ALTERNATIVE REPORT

FOR PLANNING OF

FIRST CREEK, IRONDALE GULCH AND DFA 0055 OUTFALL SYSTEMS

Prepared for

URBAN DRAINAGE & FLOOD CONTROL DISTRICT

ADAMS COUNTY

CITY AND COUNTY OF DENVER

CITY OF AURORA

CITY OF COMMERCE CITY

CITY OF BRIGHTON

Prepared by

WRIGHT WATER ENGINEERS, INC.

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THIS REPORT PRESENTS THE RESULTS OF THE ALTERNATIVE INVESTIGATION PHASE OF THE OUTFALL SYSTEM STUDY FOR FIRST CREEK, IRONDALE GULCH, AND DFA 0055 WATERSHEDS. THE EXISTING STORM DRAINAGE SYSTEM WAS STUDIED TO DETERMINE THE CAPACITY TO CONVEY THE RUNOFF FROM FUTURE DEVELOPMENT, ASSUMING THAT THE NEW DENVER AIRPORT WILL BE IN PLACE.

THE REPORT IS DIVIDED INTO THE FOLLOWING SECTIONS:

1. INTRODUCTION - REASONS FOR THE STUDY, SCOPE OF THE INVESTIGATION, GOALS, OBJECTIVES
2. STUDY AREA DESCRIPTION - BACKGROUND ON SOIL, FLOOD HAZARDS, DRAINAGE PROBLEMS
3. HYDROLOGIC ANALYSIS - SUMMARY OF THE WORK FOUND IN RIC 88188R01
4. EVALUATION OF EXISTING FACILITIES - METHODOLOGY USED TO DEFINE THE DRAINAGE PROBLEMS AND FLOOD HAZARDS
5. DEVELOPMENT OF ALTERNATIVES - PROCESS AND PHILOSOPHY UTILIZED TO DEVELOP

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December 15, 1988

Mr. Ben Urbonas, Chief
Master Planning Program
Urban Drainage & Flood Control District
2480 W. 26th Avenue, Suite 156B
Denver, CO 80211

RE: First Creek, Irondale Gulch, and DFA 0055 Outfall Systems Planning Alternative Report

Dear Ben:

Presented herein is the Alternative Report for the above referenced project. The report was prepared for the UD&FCD, the City and County of Denver, Adams County, City of Aurora, City of Commerce City and the City of Brighton in accordance with our contract dated December 4, 1987 and amended by agreements No 87-09.02B and 87-09.02C.

EXECUTIVE SUMMARY

This report presents the results of the alternative investigation phase of the outfall system study for First Creek and Irondale Gulch. The previous hydrology phase defined the flood peaks and volumes for various storms and development conditions for the two watersheds.

The study area consists of the major drainageways and the outfall drainageways of the First Creek, Irondale Gulch, and DFA 0055 watersheds. As a result of urbanization changes of the drainage patterns, the DFA 0055 watershed did not have a defined outfall drainageway and it was determined to be part of both First Creek and Irondale Gulch.

The existing storm drainage system was studied to determine the capacity to convey the runoff from future development, assuming that the new Denver International Airport will be in place (see Section IV). The evaluation consisted of comparing the capacity of facilities, such as culverts, bridges, channels, and storm sewers, to the projected flood peaks. Whereas many of the channels can convey the flood peaks, the future depth and velocity of flow will increase and cause extensive channel bank and bed erosion. As a result, channel erosion from increased base flows and the subsequent impact on environmental habitat were identified as two of the major problems in this study area. In addition, many of the street crossings will not be able to convey even the minor floods with future development. The existing storm sewers in the Irondale Gulch area were found to be inadequate for the 2-year storm recurrence interval, after infill development occurs in the undeveloped tributary areas.

Flood hazards were defined for the watersheds based on the comparisons of the system capacity to the projected flood peaks. In addition, an environmental and aesthetic assessment was prepared by William Wenk & Associates in conjunction with Dr. Erik Olgeirson and Dr. Michael Stevens. This assessment (see Section V-C) provided the basis for defining additional hazards or constraints for the proposed channels and detention areas. The primary constraints on the drainage improvements were the existing wildlife habitats, wetlands, and other aesthetic features of the area.

The dominant feature in the study area is the Rocky Mountain Arsenal (RMA), which lies essentially in the middle of the watersheds. In addition to the wildlife habitat and environmentally sensitive channels areas in the RMA, the clean-up program imposed major constraints on the drainage improvement alternatives; not only within the RMA boundaries, but upstream as well. Primary consideration in developing alternatives was given to preserving the environmental quality of the arsenal (particularly related to the base flows), and also with providing the maximum amount of flexibility to control the increased surface flows resulting from upstream urbanization. These constraints resulted in solutions which emphasized regional detention, heavily vegetated channel bottoms, or avoiding the channel bottom area altogether.

Other constraints on the alternatives included: the Commerce City area, which lacks a continuous outfall for Irondale Gulch; the Montbello area, which has an existing drainage system that is inadequate with current development; the Aurora area, which has adopted a drainage master plan including regional detention; and the lower reach of First Creek, which totally lacks a drainage system because of the historic interception of runoff by the two irrigation canals. Based on the above constraints, the alternatives investigated focused on regional detention in conjunction with conveyance system improvements.

Irondale Gulch Four plans were developed from Commerce City area to the south boundary of the RMA (ie: the lower Irondale Gulch area). Preliminary investigations found that improvements in the upper Irondale Gulch watershed (ie: Montbello and upstream) had minimal hydraulic impacts on the lower reaches of Irondale Gulch and the alternatives could be investigated independently. These four plans utilized the existing reservoir facilities at the RMA or diversion of runoff from the upstream area into Sand Creek. The alternatives in the Commerce City area were based on the previously adopted master plan for the area.

In the upper Irondale Gulch area, the alternatives focused on various locations for regional detention upstream of Chambers Road and on specific conveyance improvements within the many channels and sewers in the Montbello area itself. Two regional detention plans and an onsite detention alternative were developed and evaluated. The goal of the detention plans was to reduce the developed conditions 10- and 100-year flood peaks to existing development levels.

Conveyance improvements within Montbello were sized based on providing a uniform or minimum flood protection frequency, considering the flood peak reduction benefits of the upstream regional detention sites. In addition, the ability to convey the residual 100-year flood within the street cross section was considered.

First Creek Several regional detention schemes were developed with the objective of reducing developed flood peaks to existing flood peaks, for both the 2-year and 100-year flood. Each detention scheme was hydrologically modelled to define the peak flows. Whereas two detention combinations met the objectives, a single detention scheme was selected for further analysis, with the second scheme considered an acceptable alternative.

The selected detention scheme included a regional detention site in the southeast portion of the RMA and within the Airport Boulevard corridor, and modifications to the proposed detention sites within the Aurora area to increase the control of the minor floods.

For the First Creek channels, alternatives were developed which minimized the impact of increased base flows on the erosion and sedimentation and on the environmental aspects of the drainageways. Primary consideration was given to preserving the wildlife habitat, the wetlands and aesthetic features of the channels, while still providing for the needed flood protection.

To evaluate the alternatives for both watersheds, a numerical rating system was developed in cooperation with the District's staff, which included environmental and aesthetic aspects as well as engineering aspects. The rating accounted for the relative importance of each evaluation parameter for the individual channel segments (ie: reaches) and how well each alternative addressed the concerns of the evaluation parameter. This system was used as a guide for WWE to recommend a specific alternative and should not be considered as the final evaluation of any alternative. The results of the evaluation are presented in Tables VI-6 and VI-7.

The lower Irondale Gulch recommended alternative is Plan 2, which maximizes the utilization of existing reservoirs on the RMA. Also important to the plan is the provision of an outfall through the Commerce City area. In addition to the flood protection provided by the outfall, the outfall will allow for better control of the surface runoff through the RMA, which will benefit the clean-up program by minimizing the amount of runoff to be treated.

The upper Irondale Gulcy recommended alternative is Plan B, which utilizes mini-regional detention to reduce the developed condition 10- and 100-year flood peaks to the existing development levels. The detention then allows for 10-year level improvements within Montbello, with the residual 100-year flood for the most part being carried within the street cross section. As an

alternative to regional detention, the criteria for use of onsite detention was included.

The First Creek recommended alternative consists of regional detention within the RMA (or as an alternative, a site outside the RMA), modifications to the proposed detention within the Aurora area, and channelization which emphasizes bottom vegetation to control the increased base flows from urbanization. A flow separation structure is recommended at the O'Brian Canal and the Burlington Ditch crossings.

Wright Water Engineers, Inc. wishes to acknowledge the assistance of the project sponsors and many interested parties, without which the analysis would be incomplete.

Respectfully submitted,
WRIGHT WATER ENGINEERS, INC.

By _____
William P. Ruzzo, P.E.
Project Manager

By _____
Kenneth R. Wright, P.E.
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encl: report
871-090.010

FIRST CREEK, IRONDALE GULCH, AND DFA 0058
OUTFALL SYSTEMS STUDY
ALTERNATIVE REPORT

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ACKNOWLEDGEMENTS

The preparation of this report involved the efforts of several individuals including the staff of Wright Water Engineers, Inc., the project sponsors, and other parties with interests in the project area. A complete list of the individuals providing input to this study is presented in this report. The following individuals represented the project sponsors at all programs and meetings and provided data, drawings and other valuable information for this project.

Mr. Ben Urbonas	UD&FCD Project Director
Mr. Rocky Carns	Adams County
Mr. Darren Duncan	Adams County
Mr. Bruce Rindahl	City of Aurora
Mr. Bob Sandquist	City of Brighton
Mr. Larry Wyeno	City of Brighton
Mr. Don Wuerz	City of Commerce City
Mr. Jim Thorsen	City of Commerce City
Mr. Tom Nelson	WMD Denver

The following individuals on the staff of Wright Water Engineers, Inc. have contributed to the preparation and completion of this report:

Mr. Ken Wright	Principal-in-charge
Mr. William Ruzzo	Project Manager
Mr. Dennis Arbogast	Project Engineer
Mr. Ed Opitz	Engineer
Mr. Mark VanNattan	CADD
Mr. Pete Moros	Technician
Mr. Roger Martin	Technician

SECTION I

INTRODUCTION

SECTION - I

INTRODUCTION

A. AUTHORIZATION

This study of the First Creek, Irondale Gulch and DFA 0055 Outfall Systems (STUDY) was performed under Addendum No 1. to the contract with Wright Water Engineers, Inc. (WWE) and the Urban Drainage & Flood Control District (UD&FCD) dated April 4, 1988 (Agreement No 87-09.02A). A second addendum to the contract authorized revisions to the hydrology study to incorporate additional infiltration information (Agreement No 87-09.02B). A third addendum to the contract authorized WWE to develop and evaluate additional regional detention alternatives for the upper Irondale Gulch area (Agreement No 87-09.02C). The initial contract covered the development of hydrology (see Reference 31). Sponsors for the STUDY were Adams County (ADAMS), the City and County of Denver (DENVER), the City of Aurora (AURORA), the City of Commerce City (COMMERCE) and the City of Brighton (BRIGHTON).

The notice to proceed for the first phase (hydrologic analysis) was issued effective December 9, 1987, which established the date of February 8, 1988 for the submittal of the draft hydrology report. An extension was granted for an additional 14-days for the hydrology report because all the information for the STUDY was not received in time. The draft hydrology report was submitted on February 22, 1988. Comments were received on March 21, 1988 and the final hydrology report was submitted April 1988.

The notice to proceed for the second phase (alternative analysis) was issued on April 11, 1988, which established the date for the submittal of the draft of August 8, 1988. An extension of 25 days for the alternative analysis phase was requested by WWE and was granted by the SPONSORS to allow for sufficient time to incorporate the information from all interested parties. The draft report was submitted on September 2, 1988.

Final review comments from the project sponsors were received on October 7, 1988. At that time, the need for other regional detention alternatives was identified. Additional time for preparation of the alternatives was granted by Addendum No 2 to the contract and included time to incorporate the findings into the alternative report.

Additional written comments were received from other participants in the project. Copies of these letters are included in Appendix A to this report.

B. PURPOSE AND SCOPE

The STUDY was divided into two phases; the first phase covered the hydrologic analysis, and the second phase (this report) covered the investigation of alternatives and preparation of preliminary outfall system design.

The following tasks were included in the second phase:

1. collect data from all the sponsors and interested parties,
2. evaluate the existing drainage system to determine the capacities and deficiencies,
3. develop and evaluate a matrix of alternatives to address the deficiencies identified under item 2, based on suggestions in the contract and input from project sponsors and interested parties,
4. include erosion and operations and maintenance considerations in the development and evaluation of the alternatives,
5. prepare base mapping for the project,
6. submit a report summarizing the results of the study,
7. submit supporting calculations and data to the UD&FCD.

NOTE: additional items of work were also defined by Addendum No 1. to the contract, but these items are to be addressed during the third phase of the project, the preliminary design phase.

C. GOALS AND OBJECTIVES

The following goals and objectives for the alternative drainage solutions were identified:

1. Reduce the flooding potential of private property, to the public transportation system and to other property adjacent to the main channels and outfall drainageways with future development in the watershed.
2. Minimize the potential for erosion and sedimentation damages in the drainageways with future development in the watershed.
3. Develop cost effective, administratively acceptable and maintainable alternatives which minimize the right of way requirements.
4. Maintain and enhance the environmental, aesthetic and water quality along the drainageways.
5. Enhance the open space and recreational opportunities along the drainageways.
6. Minimize the impact of urbanization on the clean-up.

SECTION - I

INTRODUCTION

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3. Develop cost effective, administratively acceptable and maintainable alternatives which minimize the right of way requirements.
4. Maintain and enhance the environmental, aesthetic and water quality along the drainageways.
5. Enhance the open space and recreational opportunities along the drainageways.
6. Minimize the impact of urbanization on the clean-up.

D. DATA COLLECTION

During the course of the study, numerous amounts of data were made available to WWE from the project sponsors as well as from interested parties. The information included such data as copies of previous studies, maps of the existing system, land use data, agreements between developers and the Rocky Mountain Arsenal, and various city and county regulations. A complete list of information obtained and utilized in the performance of this STUDY is presented in the reference section of this report. The following is a list of agencies/individuals who were contacted during the STUDY to request participation or to obtain information:

PROJECT PARTICIPANTS AND CONTACTS

INDIVIDUAL	AGENCY	INFORMATION
Ben Urbonas	UD & FCD	FHAD & Master Plan info., infil.
Bruce Rindahl	Aurora	land use, hydrologic
Don Wuerz	Commerce City	data, hydraulic data
Bob Sandquist	Brighton	"
Tom Nelson	Denver	"
Rocky Carns	Adams County	"
John Griffith	E470 Partnership	E470 data
Donald Ramig & Larry L. Ford	S. Adams County Water & Sanitation District	utility data
Tom Fairley	Kiowa Engineering	hydrologic data
Jim Chang	Kiowa Engineering	hydrologic data
Russ.Clayshulte	DRCOG	projected land use
Brian Anderson	Rocky Mtn Arsenal	hydrologic data
James Green	Rocky Mtn Arsenal	hydrologic data
Wm. Trautman	Rocky Mtn Arsenal	hydrologic data
Ginger Evans	New Denver Airport Off.	mapping data
Adam Dechant	FRICo	no response
W. H. Ferryman	Burlington Northern RR	no response
Gary Johnson	Colo Dept. of Highways	no info. provided
Max Dodson	Environ. Protect.Agcy	no response
Denny Peters	Union Pacific RR	no response
Richard Barg	U.P. Realty Co	development plans
Wallace Stern	US Army Corps of Eng.	hydrologic data
William Doan	US Army Corps of Eng.	hydrologic data
Tyler Smart	Greiner Eng. Sciences	hydrologic data
Bob Werner	Denver Planning Off	Airport Blvd. align.
Frank Gray	Denver Planning Off	land use data
Dave Becker	Denver Planning Off	land use data
Doug Hendrixson	Denver Planning Off.	land use data
William Norton	Nat. Cart. Inf. Cntr.	mapping data
Alan Matlosz	Adams County Planning	land use data

PROJECT PARTICIPANTS AND CONTACTS
(CONTINUED)

INDIVIDUAL	AGENCY	INFORMATION
Jay Nelson	Hydro Triad, Ltd.	Parkfield devel
John Liou	FEMA-Region VIII	Floodplain info.
R. Cattany	Colo Dept of Nat.Res	no response
R. Holliday	Colo Dept of Parks/Rec	no response
J. Bruce	Greiner/MKE Team	Airport Blvd.
R. Anderson & Don Fecko	Aurora Business Centr	Development plans
L. Wilson	Rocky Mtn Cons	Development info Silverado/Elektra
J. Dillavou	Denver Parks Dept	GVR golf course
D. Mallory	Centennial Engin.	E-470 info.
C. Foster	Private Consultant	Devel plans, 56th Tower

E. MAPPING AND SURVEYS

Mapping for the project was obtained from the US Geologic Survey quadrangle maps (Coal Creek, Box Elder School, Commerce City, Sable, Brighton, and Eastlake) at a scale of 1 inch = 2,000-feet and a contour interval of 10 feet. The information was transferred to WWE CADD system, using the digital line graph data from the USGS. These data were supplemented by contour maps from the Rocky Mountain Arsenal and Green Valley Ranch subdivision, E470 Partnership maps, drainage system quarter section maps from Denver Wastewater Management, South Adams County Water and Sanitation District planning area maps, aerial photographs, the Flood Hazard Area Delineation for First Creek, and field investigations. Portions of these maps were digitized and included with the CADD data files. A list of maps utilized during the course of the STUDY is presented in the Drawing References.

F. PROJECT COORDINATION

Bi-weekly meetings were held during the course of the study to discuss the project progress and obtain project direction from the sponsors. WWE also contacted in writing other agencies and interested parties to invite them to participate in the study (see Section I-C Data Collection). Several agencies did attend the progress meetings and provide valuable information to WWE. The project meeting dates and information discussed are as follows:

PROJECT MEETING DATES

DATE	AGENDA ITEMS
April 18, 1988	initial meeting, submittal of final hydrology report, floodplain adjustment, groundwater investigation, and environmental assessment
May 4, 1988	evaluation of existing facilities, development of alternative plans for Irondale Gulch
May 20, 1988	environmental, recreational, and erosion assessment, evaluation of facilities, alternative evaluation process
June 8, 1988	additional contacts, Irondale Gulch alternative analysis preliminary results, development of First Creek alternatives
June 22, 1988	additional contacts, Irondale Gulch alternative analysis preliminary results, discussion of First Creek Alternatives
July 6, 1988	additional contacts, Irondale Gulch alternative analysis preliminary results, discussion of First Creek alternatives, alternative assessment process
July 20, 1988	additional contacts, Irondale Gulch alternative analysis preliminary results, First Creek detention sites evaluation, alternative assessment process
August 3, 1988	additional contacts, First Creek regional detention analysis, Irondale Gulch alternative cost analysis
August 22, 1988	First Creek alternative analysis results
October 7, 1988	Receipt of comments on draft alternative report from project sponsors

During the development of alternatives, various alternatives were discussed and interim selections were made at the meetings. Subsequently, WWE evaluated the alternative and presented preliminary results at the next meeting. Information was adjusted and the process repeated for several meetings. In this manner, the alternatives were refined through several steps before selecting the final set of alternatives for assessment.

G. DISCUSSION OF REPORT CONTENTS

1. Report Format

Sections I, Introduction and the Executive summary in the transmittal letter provide the reader with the reasons for the study, the scope of the investigation, and the goals and objectives.

Section II, Study Area Description provides background information on the soils, general information on the watersheds and a description of the flood hazards and drainage problems.

Section III, Hydrologic Analysis is a summary of the work performed in phase

one of this contract. More details can be found in Reference 31.

Section IV, Evaluation of Existing Facilities presents the methodology used to define the drainage problems and flood hazards in the watersheds. This was accomplished by comparing the capacity of the existing drainage facilities to the flood peaks resulting from full urbanization in the watershed. The facilities that were evaluated include channels, drainageway crossings, reservoirs and storm sewers. This information is subsequently used to develop and evaluate alternatives (Section V and VI).

Section V presents the process and philosophy utilized to develop alternatives for both watersheds. Section A, Alternative Development Process provides a brief summary of how the total universe of alternatives was narrowed to the most feasible possibilities. The alternatives were constrained or controlled by several local land use features in the watershed, such as the Rocky Mountain Arsenal, Montbello and Commerce City. How these areas affected the feasible alternatives is discussed in Section B.

The environmental and aesthetic assessment of the drainageways was performed independently of the engineering assessment. The factors considered in this evaluation are discussed in section C and recommendations for minimizing the impact of urbanization on these factors were presented. This information was subsequently combined with the engineering factors to develop the alternative categories (Section D) and the alternative plans (Section E). The alternative categories are the specific alternatives for each channel reach and the alternative plans are the combination of specific alternatives on an area wide basis.

Once the alternative plans were defined, the methodology for comparing the plans was developed, which is discussed in Section VI. The comparisons include: (1) the ability to reduce flood peaks to the capacity of the existing facilities or existing development conditions flood peaks (Hydraulic Evaluation), (2) the cost of the alternative plans (Sizing and Costing of Alternatives), and (3) a qualitative comparison of how each plan meets the goals and objectives defined for the project (see Section I-C).

Section VII, Conclusions and Recommendations presents the results of the study as they pertain to the entire study area in general and to the two major watersheds, Irondale Gulch and First Creek. References back to the pertinent sections in the report are provided.

2. How To Use This Report

Typically the reader will be interested in only a small area within the study limits and will want to know what the recommendations are and how will they affect him. To find this information the reader would need to do the following:

(a) Identify the location of the property on Drawing 6A or 6B, Routing Elements and Sub-Basin map. From this map, identify the sub-basin

(number adjacent to a small diamond symbol, such as I19 or F25) and the design point (number in the triangle). The design point is the location where flood peak data and runoff volumes can be found in Tables III-1 & 2 for the conditions with no improvements but full development or in Tables VI-1 to VI-3 for the various alternative plans.

(b) If the reader is interested in how storm runoff from adjacent areas relate to his property, then Drawing 4, SWMM Routing Schematic Diagram provides a diagram showing how each sub-basin (numbers in circles) are routed in the drainageways (numbers in boxes) to develop the combined flow a specific locations (numbers in triangles).

(c) If the reader is interested in what the intensity of the future land use might be, then Drawing 5 should be used to locate the property and identify the impervious land density symbol. The impervious percentage corresponding to the symbol can then be found in the table on Drawing 5B. More information on the hydrology of the study area can be found in Reference 31.

(d) To determine what alternatives were investigated for the area, locate the property on Drawing 7A or 7B and identify the planning reach number, such as PRI-5 (for Irondale Gulch) or PRF-6 (for First Creek). For property in First Creek, locate the planning reach in Table V-1 and read the various options that were evaluated. Description of these alternatives can be found in Section V-D and the costs can be found in VI-4. Schematic diagrams of the alternatives can be found on Drawing 9 for the possible detention sites and on Drawing 11 for specific plans.

For property in Irondale Gulch, refer to Section V-E.2, Alternative Plans - Irondale Gulch. For the property north of 56th Avenue, four plans are described in detail for each of the reaches. Schematics of the plans can be found on Drawings 10A to 10D. For property south of 56th Avenue, refer to the discussion of the two detention plans in reach PRI-7, which will describe the area wide options for detention. A schematic of the detention plans can be found on Drawing 9. For property within the Montbello area, the alternatives were limited to increasing channel and culvert crossing sizes to accommodate the various frequency flood peaks (Section V-B.3). Cost information for the plans can be found in Table VI-5.

(e) For the recommended plan in First Creek, refer to Drawing 15 for a schematic and Table VII-1 for a summary of the costs. For the recommended plan in Irondale Gulch, refer to Drawing 10B for Plan 2 schematic and Table VII-2 for a summary of the costs.

SECTION II

STUDY AREA DESCRIPTION

SECTION II

STUDY AREA DESCRIPTION

A. INTRODUCTION

The study area for the project was defined by the contract and consists of the drainage basins for First Creek, Irondale Gulch, and Direct Flow Area 0055 (see Drawing 1). These basins were delineated in the Denver Regional Council of Governments "Project Reuse" report as basins 1-01-3700, 1-01-3900 and 1-01-0055 respectively as right bank tributaries to the South Platte River between the communities of Irondale and Hazeltine. Subsequent investigations into the existing drainage patterns revealed that the direct flow area was actually part of both First Creek and Irondale Gulch drainageways and was modelled accordingly.

B. MAJOR DRAINAGE BASINS

1. First Creek

The First Creek watershed, containing 47.2 square miles, drains the area from outside of the UD&FCD boundary south of I-70 in east Arapahoe County, through the north east portion of the Rocky Mountain Arsenal, to the community of Hazeltine near the S. Platte River and 128th Ave. The basin shape is long and slender, approximately 26 miles long and 2-4 miles wide. The average slope above the Arsenal is about 31 feet per mile, which drops to about 23 feet per mile below the arsenal.

The upper reaches of First Creek are essentially undeveloped irrigated cropland with broad swales and channels for drainageways. Towards the center of the watershed, First Creek bisects Green Valley Ranch and drains through the Rocky Mountain Arsenal with more incised, low flow channels and broader flood plain areas.

The reach of First Creek below the Arsenal is bisected by the O'Brian Canal and the Burlington Ditch, which intercept the base flows from First Creek. Below the ditches First Creek becomes a less defined channel through the irrigated cropland before combining with the South Platte River.

2. Irondale Gulch

Irondale Gulch, which contains approximately 26.7 square miles, lies immediately southwest of First Creek and drains the area from the intersection of I-70 and Arapahoe and Adams county line, through the Montbello area. The south west boundary of the watershed is primarily the north side of I-70 until reaching Stapleton International Airport, where the watershed boundary lies just west of Havana Street. This watershed is also long and narrow, with a total length of 28 miles to the South Platte River and 1-1/2 to 2 miles wide.

The average slope of the watershed is about 26 feet per mile, which remains fairly constant throughout the drainageway.

The upper reaches of the watershed above the Arsenal are about 75% developed with a mixture of residential, industrial and commercial land uses. The primary developments are the Montbello area and the southerly portion of Green Valley Ranch. The upper reaches of the drainageways are broad shallow swales which change to trapezoidal concrete channels through Montbello. Two large channels, the Uvalda outfall and the Havana Street outfall, carry much of the storm runoff from the upper basin into the Arsenal.

The drainageways through the Arsenal contain several lakes and detention areas listed in Table 1. The condition under which the lakes were evaluated as a storm water detention facility is listed under "Pond Status". A wet pond assumes that the detention storage occurs only above the normal maximum water surface (ie: the elevation of the uncontrolled spillway), whereas a dry pond utilizes the entire storage area for detention.

Table 1 is for the "future development - baseline drainage facilities" condition. See Section III-H "Baseline Drainage Facilities" of the phase I hydrology report (Reference 31) for additional information. The status of the ponds was adjusted during the alternative development process.

The drainageways below the Arsenal are primarily storm sewer or road-side ditches, with capacity for only minor floods. Refer to Reference 4 "Drainage Outfall Systems Planning Northern Commerce City and Irondale Area" for details of this area of Irondale Gulch.

3. Direct Flow Areas

The project reuse report showed the Direct Flow Area (DFA) 0055 to be a separate watershed without a defined channel. The analysis for this STUDY concludes that the DFA has been modified by development and is actually part of both First Creek and Irondale Gulch watersheds. The construction of the Burlington Northern Railroad, Colorado Highway 2, and I-76 have altered the drainage patterns in the area such that the sub-basins are tributary to First Creek and Irondale Gulch. Because the portion of the DFA in the Arsenal is undeveloped and the culverts under the railroad are small (ie: less than 36"), the historic drainage patterns were altered without significant flooding.

C. SOILS DESCRIPTION

Soils information was obtained from the SCS report for Adams County and Arapahoe County (References 14 & 15). The soil associations identified in the study area are presented in Table-2 along with the classification. The A soils were combined with the predominant adjacent soil classification (mostly B soils), since the amount of A type soil was very small. The A/B and the B/C combination soils were also combined with the predominant adjacent soils. The adjacent soils for the A/B combination were generally classified B type and the B/C soils were generally classified C type.

Detailed soils information in the Denver area was not available, since the soils are considered imported by the SCS. For the Denver area, the soils were classified as B soils, based on the predominant adjacent soils.

The upper area of the Irondale Gulch basin above the lakes on the arsenal was found to have considerable more A/B combinations. This area was used by the UD&FCD to develop the characteristic infiltration parameters for type A soils. For this reason, the infiltration parameters for the sub-basins in this area were selected based on type A soils (ie: initial infiltration = 5.0 inches per hour, final infiltration = 1.0 inches per hour, and decay rate = 0.0007 per second).

A detailed soils map for the STUDY AREA is presented on Drawing-2.

D. DESCRIPTION OF REACHES, FLOOD HAZARDS, DRAINAGE AND EROSION PROBLEMS

The following sub sections present the description of the individual reaches and flood hazards for First Creek and Irondale Gulch. The reaches were defined based on jurisdictional boundaries, types of flood hazards, similar adjacent land uses, possible solution types and significant hydrological characteristics. The locations of the reaches for both drainageways are shown on Drawing 7.

The flood hazards were identified based on the estimated floodplain map prepared for First Creek (see Section IV-A of this STUDY), evaluation of existing facilities, information from the project sponsors and participants, and from the field assessments by William Wenk & Associates, Erik Olgeirson, and Michael Stevens.

1. First Creek

REACH PRF-1 SOUTH PLATTE RIVER TO COLORADO HWY 85 (D/S)
(DP 1, 0+00 TO DP 3, 143+80)

This area of the basin is primarily farm land with some areas of industrial and commercial development.

The historic base flow from First Creek has been blocked by the O'Brian Canal and the Burlington Ditch (see Reach F-2). The channel is essentially a small ditch which has been created for local drainage, lacking adequate capacity for major or minor floods from the entire First Creek basin. The channel is crossed by the Fulton Ditch, Brighton Road, and Colorado Hwy 85 in this reach. All of the crossings are inadequate to pass even the frequently occurring floods.

The flood hazards in the reach are general flooding due to lack of channel capacity, traffic interruption and erosion at the bridges, washout of the Fulton Ditch, and erosion of the channel due to increased base flow magnitude, frequency and duration.

REACH PRF-2 BRIGHTON ROAD (U/S) TO COLO HWY 2 (D/S)
(DP 2, 91+80 to DP 5, 218+80)

This reach is partially developed between Brighton Road (Colo Hwy 85) and I-76 with industrial/commercial development. Upstream of I-76, the land is irrigated farmland, which will also be developed to commercial/industrial uses.

The historic base flow from First Creek has been blocked by the O'Brian Canal and the Burlington Ditch. The channel is essentially a small ditch which has been created for local drainage, lacking adequate capacity for major or minor floods from the entire First Creek basin. The channel in this reach is crossed by Colorado Hwy 85, the Union Pacific Railroad, Colorado Highway 2, 104th Avenue, I-76, the Burlington Ditch and the O'Brian Canal, all of which are inadequate to pass the 100-year flood.

The flood hazards in the reach are general flooding due to lack of channel capacity, traffic interruption and erosion at the bridges, washout of the Burlington Ditch and O'Brian Canal, and erosion at the I-76 bridge and erosion of the channel due to increased base flow magnitude, frequency and duration.

REACH PRF-3 BURLINGTON NORTHERN RAILROAD TO E. 96th AVENUE (D/S)
(DP 5, 218+80 to DP 6, 290+90)

This reach is essentially undeveloped and is currently irrigated farmland. The area is anticipated to develop into commercial and industrial uses.

The channel in this reach consist of a small main channel and a very wide, broad overbank area, due to lack of channel definition. The channel is characterized as a cultivated alluvial swale, with some forested and backwater wetlands.

The channel is crossed by E 96th Avenue, which is inadequate to pass the minor or the major flood flows.

The flood hazards in the reach are general flooding due to lack of channel capacity, traffic interruption and erosion at the E. 96th Avenues, and erosion of the channel due to increased base flow magnitude, frequency and duration.

REACH PRF-4 E. 96th AVENUE (U/S) TO TRIB FR-3 CONFLUENCE
(DP 6, 290+90 to DP 14, 405+90)

This reach, which is entirely within the RMA property limits, is undeveloped. The area is environmentally sensitive due to the bald eagle roosting and prey habitat along the creek. The current plans for the RMA include removal of the containment basins, clean-up activities and a decrease in the land use.

A major groundwater control system has been installed along the north west boundary of the RMA. The installation consists of monitoring and containment systems.

The channel consist of a forested and shrub border along the creek bottom with broad, moderately deep overbank area. There are deciduous trees in the overbank area which provides habitat for wildlife.

There channel is crossed by 8th Avenue in this reach, which is inadequate to pass the major floods.

The flood hazards in this reach consists of interrupted traffic in the RMA, environmental damage to the habitat due to increased base flow magnitude, frequency and duration.

REACH PRF-5 TRIB FR-3 CONFLUENCE TO TRIB FR-5 CONFLUENCE
(DP 14, 405+90 to DP 38, 561+90)

This reach, which is entirely within the RMA property limits, is developed with industrial complexes, although manufacturing is currently inactive. The future plans for the RMA do not indicate that the industrial uses will be reactivated, and the facilities may be dismantled, leaving the area only partially developed.

The channel consists of a mixture of shrub dominated, forested and backwater wetlands, and cultivated alluvial swales, which provides some wildlife habitat.

The channel is crossed by 7th and 8th Avenues and F Street, which are inadequate to pass the major floods.

The flood hazards in this reach consists of interrupted traffic in the RMA, environmental damage to the habitat due to increased base flow magnitude, frequency and duration, and flooding of the industrial facilities.

REACH PRF-6 TRIB FR-5 CONFLUENCE TO DENVER CITY LIMITS
(DP 38, 561+90 to DP 51, 760+00)

This reach, which begins just downstream of the RMA east boundary and extends eastward to the Denver city limits, is essentially undeveloped land. The future projections for this area include the airport boulevard corridor and high density mixed uses.

The channel in this reach consists of a broad shallow main channel and a shallow to moderately deep overbank area. The channel is characterized by a mixture of cultivated alluvial swales, forested riparian wetlands and backwater wetlands channels, which are environmentally sensitive areas.

The channel is crossed by E. 56th Avenue, Tower Road and Buckley Road, which are inadequate to pass the minor or major floods.

The flood hazards in this reach consists of interrupted traffic and services and environmental damage to the habitat due to increased base flow magnitude, frequency and duration.

REACH PRF-7 DENVER CITY LIMITS TO PICADILLY ROAD
(DP 51, 760+00 to DP 76, 941+25)

This reach, which lies entirely within the city of Denver, is part of the Green Valley Ranch area. The area south of 48th Avenue is currently under residential development. North of 48th Avenue the area is currently undeveloped with projections for multi-family uses in the future. A golf course is planned for the lower portions of this reach.

The channel in this reach consists of a broad shallow main channel and shallow to moderately deep overbank area. The channel in the lower reach is characterized by a mixture of forested riparian wetlands and forested channels. In the upper reaches through Green Valley Ranch, the channel has been modified into the traditional trapezoidal cross section. The upper most reach of the channel is comprised of a shrub dominated drainage.

The channel is crossed by E. 48th Avenue and the East Branch of the Denver Highline Canal. East 48th Avenue has recently been improved as part of the Green Valley Ranch development and can pass the 100-year flood. The canal crosses First Creek in a flume.

The flood hazards in this reach consist of erosion and sedimentation damage to the habitat due to the increased base flow magnitude, frequency and duration.

REACH PRF-8 PICADILLY ROAD TO THE UPSTREAM STUDY LIMITS

This reach lies entirely within the city of Aurora. A drainage master plan was prepared by Simons, Li and Associates (SLA) (Reference 1) for the City and was adopted as a base line condition for this STUDY. The recommended plan includes several detention areas, which were investigated further during this STUDY to determine if additional detention sites or enlargement of the proposed sites were beneficial. For additional information concerning flood hazards and alternatives, refer to Reference 1 report.

REACH PRF-9 FIRST CREEK CONFLUENCE TO PICADILLY ROAD (D/S)
(DP 65, 0+00 to DP 80, 78+40)

This reach, which lies entirely within the city of Denver, is currently used as range land. The future projections for the area include the medium to high density residential mixed with commercial uses along the E-470 corridor.

The channel in this reach consists of a small, shallow main channel with a moderately deep, confined overbank area. The channel is characterized as a forested channel.

The channel is crossed by Picadilly Road, which is inadequate to pass the major or minor floods.

The flood hazards in this reach consist of erosion and sedimentation damage to the habitat due to the increased base flow magnitude, frequency and duration.

REACH PRF-10 PICADILLY ROAD TO THE UPSTREAM STUDY LIMITS

This reach lies entirely within the city of Aurora. A drainage master plan was prepared by Simons, Li and Associates (SLA) (Reference 1) for the City and was adopted as a base line condition for this STUDY. The recommended plan includes several detention areas, which were investigated further during this STUDY to determine if additional detention sites or enlargement of the proposed sites were beneficial. For additional information concerning flood hazards and alternatives, refer to Reference 1 report.

REACH PRF-11 TRIB. CONFL. (DF, DFL-1 TO DFL-4) TO U/S STUDY LIMITS

This reach consists of several smaller left bank tributaries to First Creek, which all combine at Colorado Highway 85. The area is currently a combination of farmland and light to medium industrial uses. The projected future development consists almost entirely of industrial uses.

The channels in this area vary from undefined swales to drainage ditches along the railroad or the various highways. The historic drainage paths have been altered by the farming and the runoff has been intercepted by the Burlington Ditch and the O'Brian Canal.

REACH PRF-12 TRIB. CONFL. (FR-2, FR-3, FR-4) TO U/S STUDY LIMITS

This reach consists of several smaller right bank tributaries to First Creek discharging within the RMA boundaries. Except for a small segment of tributary FR-3, all of the reaches are within the RMA boundary and the future land use will not change significantly from current uses. Outside of the RMA boundary, the land use in the future will be impacted by the Airport Boulevard corridor and adjacent high density mixed uses.

The channels in this area are generally broad swales, due to the relatively small amount of historic runoff, with adequate capacity for the historic floods. The channels are crossed by Buckley Road and several internal RMA roads.

The increase in base flow magnitude, frequency and duration from the small area of future urbanization will cause erosion problems in Reach FR-3 & 4.

REACH PRF-13 TRIB. CONFL. (FR-5) TO U/S STUDY LIMITS

This reach contains the second largest of the First Creek tributaries. The area, which extends from the east boundary of the RMA east to Picadilly Road, is currently undeveloped. The future land use projections in the area will be impacted by E-470 and the new airport and will consist mainly of high density mixed uses.

The channel in this reach is generally broad swales, due to the relatively small amount of historic runoff, with adequate capacity for the historic floods. The channel is crossed by Buckley Road, Tower Road, Himalaya Road and Picadilly Road.

The increase in base flow magnitude, frequency and duration from the extensive area of future urbanization will cause erosion problems in this reach.

REACH PRF-14 TRIB. CONFL. (FL-5) TO U/S STUDY LIMITS

This reach consists of a single left bank tributary to First Creek within the Green Valley Ranch subdivision. The area is a mixture of commercial, multi-family and single family development, with a golf course planned along First Creek.

The proposed drainageway consists of storm sewers and open channels, a portion of which has been constructed. The channel crosses the Highline Canal, Himalaya Road, E. 48th Avenue and other local streets.

The proposed drainage system in the Green Valley Ranch area (Reference 13) will address the potential erosion problems from the increased base flow.

REACH PRF-15 TRIB. CONFL. (FR-6A to 6C) TO U/S STUDY LIMITS

This reach consists of several smaller tributaries to FR-6 (referred to as Tributary T in the Simons & Li report, Reference 1) which drain into First Creek within the Green Valley Ranch subdivision. The area is currently undeveloped but will be impacted by the new Denver airport and will consist mainly of high density mixed uses.

The channels in this each are generally broad swales, due to the relatively small amount of historic runoff, with adequate capacity for the historic floods. The channels cross Picadilly Road in small culverts, which are inadequate to pass the future developed runoff.

The increase in base flow magnitude, frequency and duration from the extensive area of future urbanization will cause erosion problems in this reach.

2. Irondale Gulch

REACH PRI-1 PLATTE RIVER TO THE N/W BOUNDARY OF THE RMA
(DP 92 TO DP 1,78,& 81)

This reach is largely developed and lies at the most downstream section of the Irondale Gulch drainage. A detailed master plan has been prepared (Ref 4) for this reach, which only included the capacity of the culverts under the railroad as the contributing off site flow. This STUDY includes all the flow that would reach the S. Platte River if the existing facilities were enlarged or overtopped during a major flood. The peak flows and the capacities for this reach were evaluated based on the recommended system in reference 4 master plan.

The existing drainage problems in this reach consists of inadequate culverts, storm sewers and inlets and essentially a lack of a major drainage system.

The recommended system would improve the capacity for the local storm runoff, but the system would have a capacity of less than the two year flood, based on all of Irondale Gulch being tributary. One of the goals of the upstream alternatives is to increase the flood protection during a major storm over the entire drainageway.

The alternatives investigated for this reach serve only to identify the magnitude of the drainage improvements should upper Irondale Gulch continue to develop without consideration for the inadequacies of the downstream system.

REACH PRI-2: RMA BOUNDARY TO MARY LAKE D/S (DP 1 TO DP 200)

This reach is the lower portion of the Irondale Gulch area within the RMA, which is essentially undeveloped. The channel is not well defined, consisting of broad swales in most areas, due to the lack of runoff in the undeveloped state. In addition, the large lakes on the RMA (see Reach I-3) have served to contain most of the runoff from the Montbello area until recently. The capacity of the channel is adequate for the 100-year flood, but the erosion will be extensive, unless adequate facilities are provided.

The future plans for the RMA do not include substantial changes to the existing land use within the boundaries. However, as upstream urbanization increases, the base flows in the channel will increase and result in severe erosion. This problem is already evidenced by the erosion below Ladora lake due to relatively minor releases from the reservoir (ie: less than 30 cfs).

The existing culverts for the roads and the railroad crossings have adequate capacity for the minor flood.

REACH PRI-3: MARY LAKE D/S TO UPPER DERBY LAKE U/S
(DP 200 TO DP 42)

This reach consists of Mary lake, Ladora lake, lower Derby lake, and upper Derby lakes. The July 1986 USACE inspection report for Ladora lake identified the structure as "being in poor condition". There are severely eroded areas on the upstream slope of both embankments. A previous report identified the spillway capacity to be 30 percent of the probable maximum flood without overtopping. The lake is used for process water, fire protection, irrigation, and sport fishing.

A storage restriction was imposed on lower Derby by the State Engineers Office (SEO) in January 1987. Construction plans for the renovation of lower Derby dam were submitted in to the SEO in 1987 with estimated construction cost around $1,500,000. The main problems with the structure is an inadequate spillway, upstream slope stability, and trees in the embankment. The structure currently has no spillway except the overflow to gun club pond. The lake was evaluated as a wet detention with discharge to Ladora lake for the baseline condition.

Information was not available in the SEO files for Upper Derby and Mary lakes. Upper Derby lake is currently a dry reservoir, but was evaluated as a

wet reservoir for the baseline hydrologic analysis (reference 31). The operation of this reservoir as a dry facility can be considered as an alternative. Lake Mary was evaluated as a wet reservoir for the baseline condition, since a flood would generally pass straight through the reservoir with little attenuation.

The primary flood hazards in this reach are the potential overtopping of the embankments and breaching of the reservoirs from the increase in flood peaks, volumes, and duration of flows due to urbanization.

REACH PRI-4: BURLINGTON NORTHERN RAILROAD TO UPPER DFA BASIN
(DIRECT FLOW TRIBUTARIES DIL-1A,DIL-1B, DIL-IC,& DI)

This reach consists of the Irondale Gulch direct flow tributaries from the upper basin to the culverts under the Burlington Northern Railroad. Since the area is undeveloped, the channels are broad swales with little evidence of storm runoff channels. The current plans for the RMA include removal of the containment basins (ie: Basin F, which is currently being removed), clean-up activities and a decrease in the land use.

A major groundwater control system has been installed along the north west boundary of the RMA. The installation consists of monitoring and containment systems.

This reach also includes contaminated waste Reservoirs C, D, E, and F. All four of these Reservoirs are large enough to contain the total 100-year runoff without spilling. In the hydrologic model, no outflow from these reservoirs was considered for storms more frequent than the 100-year recurrence interval. Removal of the containment reservoirs will cause some but not significant impacts on 100-year runoff peaks, since the areas will remain undeveloped.

The flood hazards in these direct flow tributaries consist mainly of erosion potential from storm runoff. However, since the land use in the area is not anticipated to change from present use, there is no change in the storm runoff for the watershed. The only facilities in the area are the culverts under Highway 2 and the railroad, which are capable of passing less than the 2-year flood even without development. Consideration of the detention benefits in Reservoirs C, D, E, and F would improve the capacity of these culverts.

REACH PRI-5: LADORA LAKE TO THE SOUTH RMA BOUNDARY
(DP 8 TO DP 13, 14, 40, AND 74)

This reach contains the Havana Outfall and the Southgate detention area, which collects runoff primarily from the industrial and commercial area of Montbello. Upstream of the detention, the channel is partly a concrete trapezoidal channel and partly a earth trapezoidal channel. The transition from the concrete section to the earth section has caused severe erosion.

Southgate detention is currently a dry detention pond. During significant flood flows, the approximately 90 acre feet of storage from the invert to the spillway/dam crest will fill up and provide some flood flow attenuation.

However, the detention was modelled as a wet detention with the discharge starting at the same elevation as the storage, resulting in very little flood flow attenuation.

This approach was selected because the outlet from the pond is not sufficient to keep the pond dry and therefor the pond could be full to the spillway during major storms. Improvements to utilize the full detention will be evaluated as an alternative. The State Engineers Office imposed a restriction of zero storage in January 1987 until an adequate spillway is provided.

The channel downstream of the detention consists of sump areas above and below the Sand Creek Lateral ditch, since there has been little runoff during storms and since the lateral will intercept some of the storm runoff.

The flood hazards in this reach consist of erosion potential from the increased flood peaks, volumes, and durations due to urbanization. Also, the overtopping and breaching of the detention embankment would cause extensive damage downstream.

REACH PRI-6: UPPER DERBY LAKE TO THE SOUTH RMA BOUNDARY
(DP 42 TO DP 48, 50, 51, AND 66)

This reach contains the Uvalda Outfall channel, and the Highline Lateral drainage/irrigation ditch. For the baseline model, the smaller tributaries (routing elements 124, 143, and 139) were assumed to have separate channels. Currently the runoff from these areas are combined in a channel on the north side of 56th Ave and discharged into the Uvalda channel at the RMA boundary.

The Uvalda Outfall is a trapezoidal man-made channel which intercepts the runoff from the residential portion of Montbello. The ditch will overflow during the 100-year flood, but the overflow will either be contained adjacent to the channel or will flow to the sump area referred to s gun club pond.

The highline lateral drainage is primarily a lateral to the Denver Highline Canal which carries water rights for the RMA. The ditch was constructed in the low portion of the watershed and generally functions as a drainageway during more significant rainfall events. As urbanization increases, the base flows and flood flows will increase causing extensive erosion without improvements to the channel.

The primary flood hazards in this reach are the increases in storm runoff peaks, volumes, and durations, which can cause channel erosion and failure of the lakes in Reach I-3.

REACH PRI-7: SOUTH RMA BOUNDARY TO THE UPPER IRONDALE GULCH BASIN

This reach contains the smaller channel reaches in the Montbello, Parkside, and Green Valley Ranch developments. The main undeveloped areas lie east of Chambers Road and below Green Valley Ranch, although some infill development will occur in Montbello and Green Valley Ranch areas.

The drainageways in the Montbello area consists mainly of concrete lined channels with some collector storm sewers. Some of the channels and the street crossings have inadequate capacity for the frequent floods under current development.

The reaches were defined based on the routing elements used for the hydrological model. The alternatives for each reach were developed based on the capacity of the entire area to provide flood protection for the various frequency storms, rather than on the capacity of individual reaches. The goal was to obtain a uniform flood frequency capacity for the entire area.

The watershed from Chambers Road to Tower Road below Green Valley Ranch is mostly undeveloped, with drainageways consisting of broad, shallow, not well defined swales. The soils in the area are very permeable. The historic runoff peaks have been small and the highly permeable soils have resulted in channels which are not well defined. Several developments are proposed for this area including projects by Upland Parks, Union Pacific Reality Company, Aurora Business Center, Silverado Elektra, and Parkfield Development.

The upper area of the watershed consists primarily of the Green Valley Ranch development, which is mostly developed in the Irondale Gulch watershed. The improvements consists of onsite detention, storm sewers and open grass lined channel facilities. No flood related problems were identified in the Green Valley Ranch area.

TABLE II-1

FIRST CREEK, IRONDALE GULCH, AND DFA 0055
OUTFALL SYSTEMS STUDY

STORM RUNOFF DETENTION AREAS
(Future Development - Baseline Drainage Facilities)

DRAINAGE	DESIGN PT	NAME	TRIBUTARY BASINS	STATUS+
IRONDALE	200	LAKE MARY	LADORA LAKE	WET
IRONDALE	201	LADORA LAKE	LOWER DERBY	WET
IRONDALE	202	SOUTH GATE LAKE	HAVANA INTER PEORIA DRAIN	DRY
IRONDALE	203	LOWER DERBY LAKE & GUN CLUB POND	UPPER DERBY	WET
IRONDALE	204	UPPER DERBY LAKE	HIGHLINE LATRL UVALDA ST INTER	WET++
IRONDALE	205	GVR POND A-3	GRN VLY RNCH	DRY
IRONDALE	206	GVR POND A-2	GRN VLY RNCH	DRY
IRONDALE	207*	RESERVOIR F	RAIN FALL ONLY	WET
IRONDALE	208*	RESERVOIR C	USACE BASIN A	WET
IRONDALE	209	RAILROAD DETENTION	LAKE MARY	DRY

NOTE: * THESE RESERVOIRS RETAIN THE STANDARD PROJECT FLOOD, BASED ON THE USACE ANALYSIS

\+ A WET POND ASSUMES THAT THE DETENTION STORAGE OCCURS ONLY ABOVE THE NORMAL MAXIMUM WATER SURFACE (IE:THE UNCONTROLLED SPILLWAY ELEVATION)

++ UPPER DERBY LAKE EVALUATED AS A WET POND FOR THE "FUTURE DEVELOPMENT BASELINE DRAINAGE FACILITIES CONDITION"

TABLE II-2

FIRST CREEK, IRONDALE GULCH, AND DFA 0055
OUTFALL SYSTEMS STUDY

SOILS ASSOCIATIONS

SOIL ASSOCIATION	CLASSIFICATION
Adena loam	C
Adena-Colby	B/C
Ascalon sandy loam	B
Ascalon-Vona sandy loams	B
Blakeland-Truckton	A/B
Bresser-Truckton sandy loams	B
Fondis silt loam	C
Gravelly land-shale outcrop	C
Loamy alluvial land	C
Nunn-Bresser-Ascalon	B/C
Platner loam	C
Renohill-Buick	C
Renohill loam	C
Sandy alluvial land	C
Santanta Loam	B
Terrace escarpments	C
Tructon loamy sands	B
Valent loamy sands	A
Vona loamy sands	B
Vona-Ascalon loamy sands	B
Weld-Deertrail	C
Wet alluvial lands	B
Wiley-Adena-Renohill	B/C

SECTION III

HYDROLOGIC ANALYSIS

SECTION III

HYDROLOGIC ANALYSIS

During the first phase of the STUDY, a detailed hydrological analysis was performed for the study area (Reference 31). The study defined the basins and sub-basins, the hydraulic routing of the sub-basins, the existing and future projected land use with and without the new Denver International Airport, and the flood peaks and volumes under various development conditions for the 2-, 5-,10-, and 100-year recurrence interval storms.

Portions of the hydrological information are presented in this report for reference purposes:

TITLE	LOCATION
SOILS INFORMATION	DRAWING 2
SUB-BASIN MAP	DRAWING 3
SWMM ROUTING SCHEMATIC MAP	DRAWING 4
IMPERVIOUS LAND DENSITY WITH FUTURE LAND (W/NEW AIRPORT)	DRAWING 5
HYDROLOGIC DESIGN POINTS AN SUB-BASIN ROUTING MAP	DRAWING 6
PEAK FLOWS - FIRST CREEK (baseline cond.)	TABLE VI-3A TO VI-3C
PEAK FLOWS - IRONDALE GULCH (baseline cond.)	TABLE VI-1A TO VI-2B
RUNOFF VOLUMES - FIRST CREEK (base. cond.)	TABLE III-1A TO III-1B
RUNOFF VOLUMES - IRONDALE GULCH (base. cond.)	TABLE III-2B TO III-2B

The peak flows and volumes presented in the above locations are only for the baseline condition under future development with the new Denver airport. The baseline condition consist represents the assumed condition for routing through the various detention facilities and the combining of the sub-basins in the watershed. For additional information, refer to Section III-H "Baseline Drainage Facilities" in the hydrology report (Reference 31). The peak flows for the various alternatives were developed during this phase of the project and are discussed in Section IV-B of this report.

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TABLE III-1A

DESIGN POINT	REACH	ACCUMULATIVE RUNOFF VOLUME (ACRE FEET) 100-YR	10-YR	5 YR	2-YR
1	DF	397	133	95	30
1	MAIN	3987	1176	756	288
2	DFL1	69	28	23	10
2	MAIN	3880	1144	735	281
3	DF	328	105	72	20
3	MAIN	3832	1124	719	273
4	DFL1	33	16	14	7
4	MAIN	3368	956	595	228
5	DFL2	49	20	15	6
5	MAIN	3333	946	589	227
6	DFL2	15	6	5	2
6	MAIN	3277	933	581	226
7	DFL2	82	34	26	11
7	MAIN	2965	838	519	213
8	DFL3	16	4	3	1
9	DFL4	24	6	4	0
9	MAIN	3179	897	555	217
10	DFL4	12	3	2	0
10	FR-2	214	59	36	4
11	DFL5	29	8	5	1
11	FR-2	114	33	20	2
12	DF	160	49	32	8
12	FR-2	89	26	16	2
13	DF	113	33	21	4
13	FR-2	36	10	6	1
14	DF	43	12	8	2
14	MAIN	2851	794	486	199
15	DF	246	71	46	9
15	FR-3	252	88	61	20
16	DF	246	71	46	9
16	MAIN	2599	706	425	179
17	DFL3	30	8	5	1
17	FR-3	205	64	41	9
18	DF	216	63	41	8
18	FR-3	108	31	18	1
19	DF	192	57	37	8
19	FR-3B	97	33	23	8
20	DF	172	52	34	8
20	FR-3	86	25	15	1
21	DF	131	41	27	7
21	FR-3	74	21	13	1
22	DFL5	29	8	5	1
22	FR-3	26	8	4	0
23	FR-3A	48	13	9	1
24	FR-3	21	6	3	0
25	FR-3A	17	4	3	0
26	MAIN	2555	687	411	173
27	FL-2	162	82	68	38
28	MAIN	2393	605	343	135
29	FL-2	112	60	50	28
30	MAIN	2363	589	330	128
31	FR-3B	62	21	15	6
32	FR-3B	53	19	14	6
33	FR-3B	21	12	10	6
34	MAIN	2271	561	310	121
35	FR-4	41	9	6	0
36	MAIN	2230	552	304	121
37	FR-4	14	3	2	0
38	MAIN	2230	552	304	121
39	FR-5	327	156	128	65
40	MAIN	1903	396	176	56
41	FR-5	291	146	122	63
42	FR-5	263	140	118	63
43	FR-5	174	90	75	39
44	FR-5	99	47	39	19
45	FR-5	28	7	4	0
46	MAIN	1895	394	175	56
47	FL-3	21	5	3	0
48	MAIN	1835	378	164	54
49	MAIN	1819	374	162	54
50	FL-4	14	4	3	1
51	MAIN	1774	363	155	53
52	MAIN	1756	359	153	53
53	MAIN	1656	306	108	27
54	FL-5	100	53	45	26
55	FL-5	81	43	37	21
56	FL-5	71	37	32	18
57	FL-5	65	34	29	16
58	FL-5A	6	3	3	2
59	FL-5A	6	3	3	2
60	FL-5	40	21	18	10
61	MAIN	1642	303	106	27
62	FR-6A	43	20	16	8
63	MAIN	1599	283	90	19
64	MAIN	1599	283	90	19
65	FR-6B	27	6	3	0
66	FR-6	517	87	22	1
67	FR-6A	30	17	14	8
68	FR-6	517	87	22	1
69	FR-6C	50	12	7	0
70	FR-6	467	75	15	1
71	FR-6B	10	2	1	0
72	FR-6C	42	10	6	0
73	FR-6C	19	5	3	0
74	MAIN	1023	180	58	15
75	MAIN	1005	174	54	13
76	MAIN	969	164	47	11
77	MAIN	926	145	32	5
78	FL-6	43	19	15	6
79	FL-6	13	4	3	0
80	FR-6	467	75	15	1
81	FR-1	25	8	5	2
82	FL-5	25	13	11	6
83	MAIN	1055	190	65	18

RUNOFF VOLUMES FOR BASELINE CONDITION-FIRST CREEK EXISTING

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DESIGN POINT	REACH	ACCUMULATIVE RUNOFF VOLUME (ACRE FEET) 100-YR	10-YR	5 YR	2-YR
26	MAIN	4407	2335	1930	1118
27	FL-2	163	82	68	38
28	MAIN	4244	2253	1862	1080
29	FL-2	113	60	50	28
30	MAIN	4214	2237	1849	1073
31	FR-3B	85	43	35	20
32	FR-3B	76	41	34	20
33	FR-3B	22	12	10	6
34	MAIN	4122	2209	1829	1066
35	FR-4	50	18	14	6
36	MAIN	4072	2191	1815	1060
37	FR-4	23	12	10	6
38	MAIN	4072	2191	1815	1060
39	FR-5	366	190	158	86
40	MAIN	3706	2001	1657	974
41	FR-5	312	162	135	73
42	FR-5	262	134	111	60
43	FR-5	171	84	68	36
44	FR-5	94	41	32	16
45	FR-5	42	20	17	9
46	MAIN	3698	1999	1656	974
47	FL-3	35	19	16	9
48	MAIN	3603	1949	1614	950
49	MAIN	3578	1937	1604	945
50	FL-4	22	13	11	6
51	MAIN	3513	1906	1578	932
52	MAIN	3480	1887	1562	923
53	MAIN	3372	1826	1509	892
54	FL-5	108	61	53	31
55	FL-5	87	49	43	25
56	FL-5	77	43	38	22
57	FL-5	71	40	35	20
58	FL-5A	6	3	3	2
59	FL-5A	6	3	3	2
60	FL-5	43	24	21	12
61	MAIN	3347	1812	1497	885
62	FR-6A	54	31	26	15
63	MAIN	3293	1781	1471	870
64	MAIN	3293	1781	1471	870
65	FR-6B	54	32	27	16
66	FR-6	1192	656	561	341
67	FR-6A	30	17	14	8
68	FR-6	1192	656	561	341
69	FR-6C	101	61	53	31
70	FR-6	1091	595	508	310
71	FR-6B	23	14	12	7

DESIGN POINT	REACH	ACCUMULATIVE RUNOFF VOLUME (ACRE FEET) 100-YR	10-YR	5 YR	2-YR
1	DF	546	277	229	122
1	MAIN	6113	3084	2520	1398
2	DFL1	108	67	58	34
2	MAIN	5975	3022	2469	1373
3	DF	438	210	171	88
3	MAIN	5921	2996	2448	1362
4	DFL1	44	27	24	14
4	MAIN	5293	2670	2176	1215
5	DFL2	69	38	32	18
5	MAIN	5244	2647	2157	1206
6	DFL2	19	10	8	5
6	MAIN	5178	2625	2141	1200
7	DFL2	120	69	59	34
7	MAIN	4864	2530	2079	1187
8	DFL3	28	16	13	8
9	DFL4	36	17	14	7
9	MAIN	5079	2589	2115	1191
10	DFL4	12	3	2	0
10	FR-2	215	59	36	4
11	DFL5	29	8	5	1
11	FR-2	115	33	20	2
12	DF	169	58	41	14
12	FR-2	89	26	16	2
13	DF	113	33	21	4
13	FR-2	36	10	6	1
14	DF	43	12	8	2
14	MAIN	4750	2486	2046	1173
15	DF	318	141	112	54
15	FR-3	299	132	102	49
16	DF	318	141	112	54
16	MAIN	4451	2354	1944	1124
17	DFL3	53	31	26	15
17	FR-3	251	108	82	38
18	DF	265	110	86	39
18	FR-3	131	53	39	16
19	DF	229	93	72	32
19	FR-3B	120	55	43	22
20	DF	190	70	52	20
20	FR-3	109	47	36	16
21	DF	140	50	36	13
21	FR-3	97	43	34	16
22	DFL5	29	8	5	1
22	FR-3	38	19	16	8
23	FR-3A	59	24	18	8
24	FR-3	33	17	15	8

DESIGN POINT	REACH	ACCUMULATIVE RUNOFF VOLUME (ACRE FEET) 100-YR	10-YR	5 YR	2-YR
73	FR-6C	40	25	22	13
74	MAIN	1995	1063	858	498
75	MAIN	1967	1047	844	490
76	MAIN	1915	1021	822	478
77	MAIN	1851	983	789	459
78	FL-6	64	38	33	19
79	FL-6	25	15	13	8
80	FR-6	1091	595	508	310
81	FR-1	46	28	25	14
82	FL-5	28	16	14	8
83	MAIN	2047	1093	883	513

RUNOFF VOLUMES FOR BASELINE CONDITION-FIRST CREEK FUTURE

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DESIGN POINT	REACH	ACCUMULATIVE RUNOFF VOLUME (ACRE FEET) 100-YR	10-YR	5 YR	2-YR
1	MAIN	1453	675	591	340
3	MAIN	1315	639	567	334
4	MAIN	1298	638	566	333
5	MAIN	1281	632	561	330
6	MAIN	1225	601	534	314
7	IR-2	740	357	313	187
8	MAIN	485	244	221	127
9	MAIN	475	242	219	126
10	IL-3F	40	24	21	12
11	IL-3E	51	32	28	17
12	MAIN	427	217	197	114
13	IL-3E	51	32	28	17
14	IL-3F	40	24	21	12
15	IL-3F	18	10	9	5
16	MAIN	356	176	161	93
17	IL-3	234	103	98	56
18	MAIN	122	73	63	37
19	MAIN	122	73	63	37
20	IL-3B	59	35	31	18
21	MAIN	63	38	32	19
23	IL-3A	6	3	2	1
24	DI	104	5	21	5
24	IL-3B	8	4	4	2
25	DI	67	4	15	4
25	IL-3	174	66	66	37
26	DILIC	135	7	26	7
26	IL-3	164	60	61	34
27	DILIC	42	0	6	0
27	IL-3	139	48	50	27
28	DILIB	93	7	20	7
28	IL-3C	25	12	11	7
29	DILIC	23	0	3	0
29	IL-3	105	29	33	17
30	DILIB	56	6	15	6
30	IL-3	53	25	22	13
31	DILIA	52	4	11	4
31	IL-3D	32	15	13	8
32	IL-3D	5	0	0	0
33	IL-3	27	10	9	5
34	IL-3	8	0	0	0
35	IL-3	4	0	0	0
36	IL-3C	9	3	3	2
37	IR-2	729	356	312	186
38	IR-2	688	341	300	178
39	IL-4	41	15	12	8
40	IL-4	23	13	11	7
41	IR-2	641	314	276	164
42	IR-2	587	289	254	151
43	IR-2	329	171	150	87
44	IL-5	258	118	104	64
45	IL-5	254	118	104	64
46	IL-5C	44	19	16	10
47	IL-5	210	99	88	54
48	IL-5B	9	5	4	3
49	IL-5C	26	14	12	7
50	IL-5C	10	6	5	3
51	IL-5	210	99	88	54
52	IL-5	201	94	84	51
53	IL-5A	38	20	17	11
54	IL-5	163	74	67	40
55	IL-5A	15	7	6	4
56	IL-5	129	55	50	30
57	IL-5	105	45	41	24
58	IL-5	89	37	34	20
59	IL-5	71	28	26	15
60	IL-5	60	24	22	13
61	IL-5	47	21	19	11
62	IL-5	110	46	42	25
63	IL-5C	39	19	16	10
64	IL-5C	30	14	12	7
65	IL-5B	9	5	4	3
66	IR-2	319	170	149	87
67	IR-2	211	109	96	56
68	IR-2B	108	61	53	31
69	IR-2B	56	31	27	16
70	IR-2B	26	15	13	8
71	IR-2	125	66	59	35
72	IR-2	100	56	50	30
73	IR-2	83	48	43	26
74	MAIN	376	185	169	97
75	IR-2A	25	15	13	8
76	IR-2A	15	9	8	5
77	IR-2	58	33	30	18
78	DILIA	258	18	53	18
79	DILIC	175	14	38	14
80	DILIA	83	4	15	4
81	DI	213	23	56	23
82	MAIN	1784	733	679	378
83	MAIN	1866	773	711	395
84	MAIN	1898	793	728	405
85	IL-2	32	20	17	10
86	MAIN	1980	835	763	424
87	IL-1A	71	22	16	6
88	IL-1	28	8	6	2
89	IL-1	141	68	57	30
90	MAIN	2168	923	836	462
91	IR-1	49	25	20	11
92	MAIN	2249	955	860	473
93	IL-1A	47	17	13	6
94	DILIA	258	18	53	18
206	IR-2	35	20	18	11
207	DI	168	22	50	22
208	DI	137	12	34	12
209	MAIN	1372	657	580	339

RUNOFF VOLUMES FOR BASELINE CONDITION-IRONDALE GULCH EXISTING

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DESIGN POINT	REACH	ACCUMULATIVE RUNOFF VOLUME (ACRE FEET) 100-YR	10-YR	5 YR	2-YR
1	MAIN	1735	896	776	446
3	MAIN	1597	860	752	440
4	MAIN	1580	859	751	439
5	MAIN	1563	853	746	436
6	MAIN	1507	822	719	420
7	IR-2	988	541	477	279
8	MAIN	519	281	242	141
9	MAIN	509	279	240	140
10	IL-3F	35	20	17	10
11	IL-3E	46	28	25	15
12	MAIN	466	258	222	130
13	IL-3E	46	28	25	15
14	IL-3F	35	20	17	10
15	IL-3F	15	8	7	4
16	MAIN	363	195	166	97
17	IL-3	241	121	102	58
18	MAIN	122	74	64	39
19	MAIN	122	74	64	39
20	IL-3B	57	35	30	18
21	MAIN	65	39	34	21
23	IL-3A	9	5	4	3
24	DI	104	31	21	5
24	IL-3B	8	5	4	2
25	DI	67	22	15	4
25	IL-3	186	88	73	41
26	DILIC	135	36	26	7
26	IL-3	178	83	69	39
27	DILIC	42	9	6	0
27	IL-3	143	64	53	29
28	DILIB	93	27	20	7
28	IL-3C	35	19	16	10
29	DILIC	23	5	3	0
29	IL-3	116	49	40	21
30	DILIB	56	19	15	6
30	IL-3	64	33	29	17
31	DILIA	52	16	11	4
31	IL-3D	57	33	29	18
32	IL-3D	30	18	16	10
33	IL-3	44	23	20	12
34	IL-3	26	14	12	7
35	IL-3	22	14	12	7
36	IL-3C	18	10	8	5
37	IR-2	977	540	476	278
38	IR-2	939	528	466	272
39	IL-4	38	12	10	6
40	IL-4	20	10	9	5
41	IR-2	892	501	442	258
42	IR-2	809	454	401	234
43	IR-2	396	223	196	114
44	IL-5	413	231	205	120
45	IL-5	409	231	205	120
46	IL-5C	39	15	14	7
47	IL-5	370	216	191	113
48	IL-5B	8	4	4	2
49	IL-5C	22	11	10	5
50	IL-5C	8	5	4	2
51	IL-5	370	216	191	113
52	IL-5	362	212	187	111
53	IL-5A	39	21	19	11
54	IL-5	323	191	168	100
55	IL-5A	20	11	10	6
56	IL-5	295	176	155	92
57	IL-5	259	157	139	82
58	IL-5	244	149	132	78
59	IL-5	226	140	124	73
60	IL-5	191	118	105	62
61	IL-5	128	79	70	41
62	IL-5	273	164	145	86
63	IL-5C	34	15	14	7
64	IL-5C	26	11	10	5
65	IL-5B	8	4	4	2
66	IR-2	386	222	195	114
67	IR-2	295	174	154	89
68	IR-2B	91	48	41	25
69	IR-2B	52	28	24	15
70	IR-2B	23	13	11	7
71	IR-2	174	103	92	53
72	IR-2	123	74	66	38
73	IR-2	93	56	50	28
74	MAIN	420	230	197	115
75	IR-2A	27	16	15	8
76	IR-2A	16	10	9	5
77	IR-2	66	40	35	20
78	DILIA	258	74	53	18
79	DILIC	175	51	38	14
80	DILIA	83	23	15	4
81	DI	214	76	56	23
82	MAIN	2077	1023	874	490
83	MAIN	2187	1090	932	524
84	MAIN	2219	1110	949	534
85	IL-2	32	20	17	10
86	MAIN	2307	1158	990	557
87	IL-1A	87	39	30	16
88	IL-1	41	21	18	10
89	IL-1	171	98	84	48
90	MAIN	2530	1281	1095	616
91	IR-1	56	31	26	15
92	MAIN	2628	1329	1134	637
93	IL-1A	48	19	14	7
94	DILIA	258	74	53	18
206	IR-2	40	24	21	12
207	DI	169	66	50	22
208	DI	138	47	34	12
209	MAIN	1654	878	765	445

RUNOFF VOLUMES FOR BASELINE CONDITION-IRONDALE GULCH FUTURE

SECTION IV

EVALUATION

OF

EXISTING FACILITIES

SECTION - IV

EVALUATION OF EXISTING FACILITIES

Existing drainage facilities were evaluated to determine the capacities of the facilities such that the deficiencies and potential flood hazards could be defined. This information was then used to develop and evaluate alternatives. The methodology used and the results of the analysis are presented in this chapter. The estimated facility capacity was compared to the flood peaks for the existing and future developed runoff from the 2-, 5-, 10-, and 100-year floods. The evaluation of the existing drainage facilities is limited to determining the capacity and general condition and generally does not include evaluating the structural integrity of the facility. The facilities evaluated included channels, storm sewers, and detention facilities.

A. CHANNELS

Information on existing channel facilities was gathered from as-built and planning maps from the City and County of Denver, the Rocky Mountain Arsenal, and Green Valley Ranch. Wright Water Engineers also used USGS topographic maps to establish channel characteristics.

In cases where actual channel cross-sections were available (generally in Irondale Gulch through Montbello and Commerce City), WWE calculated capacities for conveyance elements by applying Manning's equation to those cross-sections, using appropriate Manning values and slopes shown on plans or calculated from the topography. Where existing channel types varied over the length of a single conveyance element, the capacity of the typical channel type found within that sub-reach was applied to the element. In the Montbello area (planning reach PR-7), the capacity of the streets adjacent to the channels were also considered. The gutter capacity was calculated using design curves for allowable capacity for major and minor storms (Adams County Storm Drainage Design and Technical Criteria, Draft 1987, figures 1003 and 1004).

In cases where no improved channel exists or information was not available (generally the undeveloped reaches of First Creek and Irondale Gulch through the Rocky Mountain Arsenal), WWE determined the capacity of each conveyance element by approximating the channel as a trapezoid with varying bottom widths, side slopes, and roughness factors. The slope was calculated using the project mapping and USGS topographic maps.

In each case, the normal and critical depth of flow was then calculated and compared to the average bank full depths. The capacity was then compared to the developed condition flood peaks (which were developed using the UDSWM-2PC computer runoff routing model) to identify any flood hazards and to determine areas where channel upgrading was necessary.

In First Creek planning reaches PRF-8 and PRF-10, the existing channel conditions and capacities were taken to be those of the Simons, Li and Associates drainage master plan for the City of Aurora. This is consistent with the adoption of the Master Plan by the City of Aurora and with discussion and consensus in the bi-weekly planning meetings with UD&FCD.

B. STORM SEWERS

Storm sewers are located in the Montbello and Commerce City areas of Irondale Gulch. The capacity of the Montbello storm sewer was calculated using the slopes and pipe diameters listed on the "STORM" 1/4-section drawings of the City and County of Denver and "Flow for Circular Pipe Flowing Full" tables (Concrete Pipe Design Manual, p. 192 figure 5). Allowable street flows were included in the existing capacity and were calculated as described above for channel capacity.

For the Commerce City area, the existing condition was taken to be the recommendations in the Commerce City Master Drainage Plan, prepared by McLaughlin Water Engineers, Inc. The capacities listed on the McLaughlin plans were compared to the flood peaks generated by WWE SWMM analysis to determine the capacity of the system. The storm sewer system proposed in the McLaughlin report has not been constructed as of the date of this report.

C. DETENTION AREAS

Nine planned detention areas and one inadvertent detention area were identified and modeled for the base line condition in the Irondale Gulch Basin (see Table II-1). Except for the two ponds in Green Valley Ranch, all these detention facilities are located within the Rocky Mountain Arsenal.

The capacity-discharge information for the two Green Valley Ranch detention ponds were obtained from Greiner Engineering Sciences, Inc. (Reference 22). This data was evaluated, plotted, and input into the SWMM program for detention routing. The input data is presented in hydrology report for the study area (Reference 31). The two ponds within the Green Valley Ranch area were used for the baseline condition, since they are under the jurisdiction of Denver Wastewater Management. Another Green Valley Ranch pond at Tower Road has been identified as being a temporary diversion and therefore was not modeled as a pond but as a conveyance element (number 138) that has not been diverted.

The baseline condition for the detention sites within the Arsenal are presented in Table II-1. A "wet" pond assumes that the detention storage only occurs above the normal maximum water surface (ie. the controlled spillway elevation). Additional information on the routing for the existing detention facilities can be found in the hydrology report (Reference 31).

The hydrological modelling for the upper First Creek Watershed (see Drawing 6) was prepared by Simons, Li and Associates (Reference 1). WWE use the SLA model to develop the baseline conditions for this part of the First Creek Basin. There are no existing detention facilities in the First Creek Basin.

E. FIRST CREEK FLOODPLAIN

A major drainageway planning study for First Creek was performed by Engineering Consultants, Inc. (ECI) in 1977 (Reference 3). The ECI analysis included definition of flood peaks with future development, floodplain delineation, and proposed improvements. This report was adopted by the Colorado Water Conservation Board (CWCB) and is currently used for floodplain regulation.

The future development condition assumed in the ECI study resulted in an overall basin imperviousness of approximately 23 percent, whereas the WWE future projections with the new airport resulted in a 48 percent imperviousness for the total First Creek Basin.

As part of this Phase 2 study by WWE, an estimate was made of the increase in floodplain resulting from the increased runoff due to development. The SWMM model was created which reflected the developed conditions without any storm drainage improvements. The resulting flood peaks were translated to normal water surface depths via Manning's equation for the modeled channel cross-section. The corresponding water surface elevation was then plotted on the ECI drawings to give an estimate of the impact of developed runoff on the existing floodplain. The results showed:

(a) An increase in floodplain width at Brighton Road from around 400 - 450 feet to 450 - 500 feet. The average increase in flood depth is approximately 1.5 feet.

(b) An increase in the floodplain width northwest of U.S. Highway 85 from around 1200 - 1500 feet to 2000 - 2300 feet. The average increase in flood depth is approximately 2.0 feet.

(c) A minor increase in the floodplain width in the reach between I-76 to the RMA boundary of approximately 50 feet. The existing floodplain width varies from 800 to 1500 feet. The depth increases approximately 1.5 feet.

(d) An increase in the floodplain width between Buckley Road and Tower Road of around 400 feet. The existing floodplain width varies from 200 to 800 feet wide. The average depth increases by approximately 1.5 feet.

(e) An increase in the floodplain width downstream of Picadilly Road of around 100 to 200 feet. The existing floodplain width varies from 200 to 500 feet. The average depth increases by approximately 1.5 feet.

(f) An increase in the floodplain width upstream of Picadilly Road of around 100 to 300 feet. The existing floodplain varies from 150 to 300 feet. The average depth increases by approximately 1.5 feet.

(g) An increase in the floodplain width in the upper reaches from around 100 to 200 feet. The existing floodplain varies from 400 to 1000 feet wide.

SECTION V

DEVELOPMENT

OF

ALTERNATIVES

SECTION - V

DEVELOPMENT OF ALTERNATIVES

A. ALTERNATIVE DEVELOPMENT PROCESS

The development of alternatives involved an iteration process consisting of several steps. The first step was the identification of specific constraints for each of the sub-areas of the watershed. For instance, the Rocky Mountain Arsenal has specific requirements to maintain the existing reservoirs and to preserve the existing groundwater conditions so as to not interfere with the clean-up of the arsenal. These and other constraints are discussed in further detail below.

The second step in the process was to define a matrix of possible alternatives for each of the channel reaches. In the Irondale Gulch watershed, the possible solutions included erosion/sedimentation control, channel improvements, detention, road crossing improvements, diversion, and storm sewers. The possible solutions were developed based on the constraints for each reach, the environmental and aesthetic considerations, and the flood control requirements. Only the feasible solutions were included in the master matrix, based on a qualitative review by WWE. This master matrix was then presented to the project sponsors for review and approval.

An example of a master matrix and the screening process for First Creek is presented in Table V-1. For each reach, the description of the reach, the jurisdiction, the future land use and the potential flood hazards are summarized in the left portion of the table. On the right side of the table, the possible solutions are listed (ie: STATUS QUO FLOOD PLAIN MANAGEMENT, ENGINEERED FLOODWAY IMPROVEMENTS, etc.). For each reach, the alternative was qualitatively evaluated to determine the feasibility for that reach and a comment was made regarding the feasibility. For Reach PRF-1, Status Quo was considered viable, provided base flow control was included in the overall solution. However, the Engineered Hard Lined Channel was not considered viable because there is adequate ROW for a grass channel, which is the preferred alternative type.

B. AREA CONSTRAINTS ON ALTERNATIVES

IRONDALE GULCH WATERSHED

1. Commerce City Area

The Commerce City area lies within the Irondale Gulch Watershed, downstream of the RMA. The area was previously investigated for flood hazards and drainage alternatives and a recommended solution has been adopted (Mc Laughlin, Reference 4). This solution consists of storm sewers, open channels and detention areas.

WWE has included the proposed outfall system of the Commerce City area in this analysis to provide a continuous flow path from the upper Irondale Gulch watershed to the South Platte River. This aspect is also important for the surface water management within the RMA.

The Commerce City plan was based on the local runoff and did not include the runoff from the total Irondale Gulch watershed. However, the detention in the RMA and the undeveloped portions of the RMA serve to keep the projected future development flood peaks from greatly increasing in the Commerce City area. As a result, the level of flood protection provided by the Commerce City plan using only the local runoff was found to be similar when the entire upstream watershed was included.

The costs for the outfall were included in each of the investigated plans for Irondale Gulch. In addition, WWE included an alternative which provides 100-year protection along the outfall drainageways. This analysis provided the basis for evaluating the selected plan for Commerce City using the runoff from the entire watershed.

2. Rocky Mountain Arsenal (Irondale Gulch)

Within the RMA boundaries there are two basic constraints; (1) the future development runoff must be controlled such that the clean-up of the RMA is not negatively impacted, and (2) preservation of the environmental and aesthetic aspects of the RMA must be included in the drainage and flood control solutions.

With regards to the RMA clean-up, the following additional constraints were identified:

> the alternatives should provide the maximum amount of surface flow control in the plan by incorporating improvements to Havana Pond and Upper Derby reservoirs.
>
> the alternative should minimize the potential for changes in the groundwater regime by utilizing the existing reservoirs sites to the maximum extent possible and maintain those reservoirs not needed for surface water control.

The above constraints were identified by representatives of the RMA and Shell Oil Company in order to minimize the impact of any changes on the groundwater regime in the RMA. Currently, the contamination lies in the soil horizons just above the groundwater table. If the groundwater table changes, it could alter the direction of the contaminate plume and impact the clean-up program. The basis for the clean-up plan is the assumption that the current groundwater conditions would not change . With increasing urbanization, the storm runoff and the irrigation water (imported water) could change the groundwater levels. However, the exact impacts of the proposed alternatives could not be determined by the RMA and Shell Oil Company representatives at this time in the clean-up program.

With regards to the environmental/aesthetic aspects the following additional constraints were identified:

the alternatives should minimize the changes to the channel environment due to the extensive wildlife habitat that would be affected, including the bald eagle and the black-footed ferret habitat.

the alternative should control, to the maximum extent possible, the increase in base flows which will result from increased urbanization upstream.

Based on the above constraints, the existing detention areas in the RMA were identified and evaluated as surface water control facilities. The only existing detention sites were found to be in the Irondale Gulch watershed. These are listed in Table V-2 and noted as to the status for each of the alternative plans for Irondale Gulch.

3. Montbello Area

The Montbello area (from the RMA south boundary east to Chambers Road) is a mixture of existing industrial, commercial and residential land uses. The existing drainage system consists primarily of storm sewers, concrete open channels and culverts. The alternatives in this reach were limited to upgrading the road crossings and increasing the channel capacity to carry the future developed runoff. Consideration was given to the capacity of the streets adjacent to the channels to carry the residual flows up to the 100-year flood. Also, "mini-regional" detention was considered in the upper basin to reduce the costs of improvements required for the existing developed areas downstream of Montbello.

4. Upper Irondale Gulch

The area east of Chambers Road is undergoing development, with the main tracts of land being the Parkfield development, the Silverado/Elecktra land (Upland Parks), Green Valley Ranch, the Union Pacific Reality Company (UPRC) land, and the Aurora Business Center (ABC). During the course of the analysis, WWE communicated with the representatives from each of these land owners to coordinate the selection of alternatives with the proposed plans for the development.

The Green Valley Ranch (GVR) and the Aurora Business Center (ABC) have detailed development plans, which were incorporated into either the existing system model or the possible alternatives. The GVR detention ponds were accounted for in the future development runoff conditions model. The ABC 100-year future development conditions runoff was reduced to approximately 450 cfs at the boundary by simulating the detention in a single storage area.

For the Parkfield development, WWE incorporated the proposed large detention area into the alternative plans. Previous hydrological studies of the area have resulted in a 100-year peak flow of around 1900 cfs at the intersection of Chambers Road and 56th Avenue. This value has been used for earlier planning purposes and was a basis for the understanding between the City of Denver and the RMA. A design constraint for this study, therefore, was to reduce the 100-year future developed peak runoff to 1900 cfs or below.

Since neither the Upland Parks or the UPRC land have detailed storm drainage plans at this time, WWE incorporated mini-regional detention in each of the outfall drainageways. Detention was considered in various areas of the watershed, including the area immediately upstream of the proposed airport boulevard and Chambers Road.

FIRST CREEK WATERSHED

5. South Platte River Area

The area northwest of Highway 2 is primarily farm land with some industrial development. Because the upper basin is essentially undeveloped and because the historic runoff has been intercepted by the local irrigation facilities (ie: the O'Brian Canal, the Burlington Ditch and the Fulton Ditch), the natural drainage channel is not well defined and has been encroached upon by the adjacent land uses.

The possible solutions in this area were constrained by the magnitude of the projected flood peaks. Alternatives were limited to variations of large grass lined channels or other natural channel sections.

6. Rocky Mountain Arsenal (First Creek)

In addition to the constraints for the Rocky Mountain Arsenal within the Irondale Gulch area (Section V-B.2 above), the following constraints apply to the First Creek area.

For the First Creek watershed, the possible detention sites (ie: Henderson Hill and Greens reservoir site, see Section V-E below) were evaluated for their impact on the clean-up program. For the Henderson Hill site, which is off channel storage, the base flows would continue in the channel, thereby maintaining the groundwater regime and the habitat. Since the major storm flows would be stored only temporarily, the impact on the groundwater regime was considered negligible. For the Greens reservoir site, a liner for the 2-year flood storage was included in the cost to minimize the impact on the groundwater regime.

7. New Denver International Airport

This area lies between Highway 2 and the Aurora boundary around Picadilly Road and lies mostly within the RMA. Whereas only a portion of the actual airport

influence the channel profile, i.e., agricultural, and may also determine the future potential for recreational use or erosion.

2. TYPICAL CHANNEL UNITS

The following is a brief description of each of the typical channel units as determined by the inventory criteria. Each of the units are distinct channel types with a typically occurring channel profile and vegetative cover.

(a) Agricultural/Cultivated Alluvial Channel

This unit is typically characterized by a distinct, usually narrow, low flow channel, which disperses high flows to adjacent agricultural fields. The channel is usually a modified stream reach where riparian and wetland vegetation has been removed for agricultural use and the stream has been channelized. Vegetation is comprised primarily of grasses with little or no wetland or riparian vegetation.

(b) Engineered Floodway

Designed to accommodate high flows within a typical cross section the engineered floodway is characterized by a narrow shallow low flow, a wide channel bottom area and high rounded banks. The dominant vegetation is mostly temporary and herbaceous. Wetland grasses occur in the bottom area and upland prairie grasses occur along the sides and tops of the embankments. Vegetation is dominated by introduced species.

(c) Shrub Dominated Channel

The shrub dominated channel is typically eroded along the outside bank, which is fairly gently sloped and vegetated. The eroded embankment is very unstable and is covered by a thin herbaceous layer. The low flow channel is sinuous, varying in size, and may even split, flowing between bars occurring in the channel bottom. The channel is dominated by shrub species, primarily willow, with prairie upland grasses occurring along the gentler slopes. The bars within the channel bottom are heavily vegetated with shrubs.

(d) Forested Channel

The channel is typically characterized by relatively stable embankments with the cross section varying from narrow to broad. In several locations the channel has been excavated to accommodate the low flow, and in others the low flow has followed its own course. Vegetation is comprised primarily of large, mature deciduous trees with a well-developed herbaceous layer, and occasional shrubs or small trees. The channel generally is not vegetated and the mature trees grow along its edge. This unit is a very significant wildlife habitat because of its mature trees. Bald eagles and red-tailed hawks have been identified roosting along First Creek in several locations.

(e) Forested Riparian Wetland

The most diverse channel profile in both cross section and vegetation is the forested riparian wetland. Areas identified in this unit are the most stable and also the most environmentally sensitive. The channel is generally very broad with meandering low flows and a defined high flow ridge. The vegetation varies from wetland grasses, shrubs and small trees throughout the channel bottom, to large mature trees along channel edges and up onto the sloping embankments. Due to the diverse vegetation and broad channel bottom this unit is considered a stable riparian environments.

(f) Backwater Wetland

Characterized by an expanded wetland area, backwater wetlands are seasonally flooded due to an abrupt change in the channel created by natural morphology or some other obstruction. A well-developed shrub and emergent wetlands typically occurs in the channel. The channel profile is generally comprised of multiple low flow channels and the high flow is unidentifiable. Vegetation varies from shrubs to small trees and is typically very heavy.

The six typical channel units are illustrated in Drawing 12 and then mapped according to their locations along First Creek in Drawing 13.

Some sections of the natural stream reaches are stable because there is little, if any, surface runoff. These areas combine a variety of mapped units including Forested and Shrub Channels, Prairie Swales, Cultivated Channels and Engineered Floodway. Irondale Gulch near the western boundary of the arsenal is an example of such a reach. In other sections of natural stream reaches, one bank is stable and the other is eroding. A section of First Creek immediately upstream from the crossing of the Highline Canal is an example of this condition. These are Forested and Shrub Wetlands.

When urbanization of the catchments begins, the additional runoff and decrease in sediment supply to the stream will cause extensive degradation of the stream beds and erosion of their banks. Stabilization of the streams will prevent this from occurring.

3. CHANNEL ALTERNATIVES

A large number of alternatives for the stabilization of First Creek and Irondale Gulch have been condensed into three types for simplification. The objective of each alternative is to control stream velocity.

(a) Control with vegetation

This technique will reduce water velocities to the non-eroding value for the vegetation. Control is achieved with vegetation. A broad floodplain will be constructed and vegetated, and will resemble a natural, open park with a sinuous low-flow channel. Flood waters will spill onto the adjacent broad floodplain and make their way downstream at low velocities. The sinuous

channel will be ineffective during floods. No erosion will occur in the low-flow and high-flow channels. No structures, rock or concrete will be used in conjunction with vegetation. This approach requires the most land area for the floodplain.

The balance between the driving hydrological factor and the responsive vegetation factor is critical to maintaining stability of the channel. Planting zones are equally critical to perpetuating the floodplain. Natural vegetation succession will be controlled by the system to maintain these zones. Native willow (Salix exigua) will be introduced into the area occupied by the sinuous low-flow channel. These plantings will be sustained by the varied flow regimes, especially the lower soil moisture periods during the summer. The absence of clay particles in the system will not favor incidental cottonwood regeneration in the low-flow area. Cottonwood (Populus sargentii) will be planted on the high bank areas of the floodplain. Only androgynous (male) plants will be introduced by planting to reduce the seed source. The outer areas of the floodplain can be planted with additional species to increase diversity for wildlife, dogwood (Cornus stolonifera), snowberry (Symphoricarpos albus), chokecherry (Prunus virginiana), wood rose (Rosa woodsii) and clematis (Clematis occidentalis). Herbaceous species will also be seeded into the floodplain.

(b) Control with rigid materials

This approach will allow high velocities and will prevent erosion by making the banks and bed rigid. The prismatic concrete-lined channel is the most common example of this technique. The most efficient cross section is trapezoidal with 1:1 side slopes and a top width-to-depth ratio of 2. This section requires the least land for the floodplain. It is proposed that this approach use a modified cross section with variations in form to produce a more aesthetic result. A rigid channel will be constructed with the cross sectional form of a typical alluvial channel: broad with bars, changes in cross sectional shape, steep shallow banks and sinuous planform. This alternative would be limited to areas outside of the city of Aurora, since Aurora currently prohibits concrete lined channels.

(c) Control by vegetation and structures

In this situation velocities will be controlled with rapids and drop structures. Bank erosion will be controlled with vegetation in combination with rigid materials, such as concrete, stones and grouted riprap. Numerous combinations of vegetation, rigid materials; and stream cross sectional and planform shapes are possible in this design. The planform of the channel will be sinuous, so that only one bend requires stabilization. This approach will require an intermediate amount of land for the floodplain, but larger than the current area.

Vegetation is simply cosmetic on this approach. Plant materials will be selected to provide additional stabilization through extensive and highly fibrous roots. A diversity of species and life forms can also be used for

enhancement of wildlife habitat and aesthetics. Candidate species include cottonwood, willow, snowberry, red osier dogwood, chokecherry and clematis. Planted areas will also be seeded with native grasses.

It may be feasible to limit the amount of surface runoff from parts of the First Creek and Irondale Gulch catchments with detention ponds and infiltration depressions. Detention ponds are a single use facility: land dedicated to storing flood waters. Infiltration depressions are multiple use and must be limited in area. Surface runoff is collected in the surface depression where it evaporates and infiltrates into the sandy soil. The depression can be cultivated or planted in a manner that does not impede infiltration. This land form resembles naturally occurring Prairie Swales.

4. Threatened, Endangered and Candidate Species

The U.S. Fish and Wildlife Service, at the request of WWE, provided a list of threatened, endangered and candidate species which do or may occur on the Rocky Mountain Arsenal. The letter with the species list is presented in Appendix A, and includes the bald eagle (does occur), the peregrine falcon (may occur) and the whooping crane (may occur). The black-footed ferrets have been surveyed but the species is not currently on the RMA. Other species of raptors, including Swainson's hawk and ferruginous hawks have also been identified on the arsenal, both which are candidates for federal listing.

D. ALTERNATIVE CATEGORIES

1. Engineering Considerations

The basic concepts evaluated for the drainageways in this study can be summarized in the following four categories:

(a) Channelization

Channelization is the confinement of runoff to engineered or natural channels which are best suited to the particular reach when considering right-of-way width, cost of construction and maintenance, property and transportation flooding, erosion and sedimentation.

(b) Diversion

Diversion is the redirection of runoff from its natural channel to another part of the same watershed or another watershed altogether.

(c) Detention/Retention

Detention and retention are the accumulation of runoff in storage facilities for the purpose of delaying its release and thus reducing the peak flow and volume the downstream system must accommodate. Benefits include enhancement of water quality, multiple use (ie. recreation/open space), and regional versus on-site facilities. Retention in strict sense was not considered an

option in this study but this term has been applied to the delayed release (within forty eight hours) of accumulated runoff from a storage facility.

(d) Selected Structural Solutions

Selected structural solutions are mitigation of local problem areas in the system such as bridges and culverts. Also included are check or drop structures for erosion control and flow separation structures at canal crossings.

The above categories were used to develope the individual plans for Irondale Gulch and to define the master matrix of alternatives for First Creek.

(e) On-site Detention

As an option to regional detention for the upper Irondale Gulch area, the requirements for on-site detention were developed. The criteria for onsite detention is to reduce developed peak flows to the approximate capacity of the existing facilities within the Montbello area. This same criteria was used to size the regional detention plan (see Plan B, Reach PRI-7, Section V-E.2).

To achieve this goal, the pond release requirements were determined by dividing the target peak flow in cfs by the projected impervious area in acres. This approach assumes that the peak flows will be directly additive and accounts for both existing and future development. The release rates for the three major tributaries to Montbello (ie: Tributaries IL-3, IL-5 and IR-2) are presented in Table VI-9.

The pond volume requirements were determined by subtracting the future development runoff volume from the historic runoff volume for typical design points in upper Irondale Gulch. This approach accounts for the very permeable soils in upper Irondale Gulch. These values were then plotted versus impervious percentage (See Table VI-9).

2. Environmental and Aesthetic Considerations

The combined analysis by Wenk and Assoc., Stevens and Olgeirson led to the development of four channel types which would apply to the range of physical conditions and peak flows encountered in the study area. A fifth option in channel types is the construction of drop structures and erosion protection only as need to the existing channel. As with any analysis, the 'do nothing' or status quo management option was also included. The recommendations made were not exclusive of the engineering considerations of WWE but, for the most part, enhancements of the required engineering solutions to include environmental and aesthetic improvements.

The channel types considered are shown in Drawing 15 and listed below:

(a) Natural Open Space Conveyance

This alternative takes advantage of areas of existing mature vegetation, anticipated open space areas or protects sensitive wildlife habitat or wetlands vegetation.

(b) Engineered Grass/Wetland Channels

This alternative utilizes vegetation to stabilize channel banks and improve appearance in areas of either restricted rights-of-way or existing wetland vegetation.

(c) Engineered Floodway

This alternative allows for restriction of the floodway with embankment material in areas of large peak flows and undefined main channels or broad floodplain in areas under pressure for development (ie. lower First Creek in Adams Co.).

(d) Hard Lined Channel

Although not inherently aesthetic, this channel type does not always refer to a concrete lined trapezoid. Variations of riprap lined channels or channels banks lined with sand/cement, both with a sinuous alignment and 'vegetation islands' allows channelization in restricted rights-of-way at relatively high velocities. Concreted lined channels are currently prohibited within the city of Aurora.

Various combinations of the channel types mentioned above are possible. For instance, a reach may contain a hard lined main channel designed to convey the 10-year flow with an overbank area for vegetation, trails and maintenance access as well as the 100-year storm capacity. Channels may also include reaches of split flow which can direct major storm runoff around environmentally sensitive or erosive areas and into detention, retention, or overflow facilities.

E. ALTERNATIVE PLANS

1. Process of Selection

After the entire list of alternatives was narrowed to the viable solutions, the next step was to begin further analysis of each possibility. The analysis consisted, in some cases, of combining the possibilities for each reach into the hydrologic model and determining the flood peaks for the particular set of solutions. This information was then presented to the project sponsors and other interested parties at the bi-weekly progress meetings. Modifications and additions to the alternatives were suggested and WWE recalculated the hydrologic results and began conceptual sizing of the facilities and calculating the costs. This information was also presented at the bi-weekly meetings with further adjustment of the alternative concept. In this manner, the alternatives for First Creek and Irondale Gulch evolved into the selected set of solutions presented in this report, but only after several iterations

resulting from the sponsor's input.

2. Irondale Gulch

The storm drainage alternatives in the Irondale Gulch Basin were developed pursuant to several major goals which are presented below.

(a) Maintain developed conditions stormwater peak flows at or below existing levels, particularly across the Rocky Mountain Arsenal.

(b) Develop feasible and cost effective plans that can be implemented with phased development.

(c) Maintain flexibility in stormwater routing and storage and provide an outfall through Commerce City to aid in surface water management and clean-up activities on the Rocky Mountain Arsenal.

(d) Investigate the impact of upstream development on existing facilities in Commerce City and, if necessary, identify drainage improvements to mitigate those impacts.

(e) Reduce the impact of increased flood peaks on existing facilities in the Montbello area while still accommodating projected development in the upper Irondale Gulch Basin.

(f) Provide an option for the partial or total diversion of stormwater flows upstream of the RMA to other areas.

(g) Reduce the erosive effects of increased base flows due to development on existing channels.

WWE pursued four alternative plans which address the aforementioned goals. The key features of each plan are described by individual planning reach and are as follows;

PLAN 1

MAXIMUM UTILIZATION OF EXISTING FACILITIES (REFER TO DRAWING 10A)

REACH PPR-1: This plan incorporates the recommendations from the McLaughlin master plan for the Commerce City area. Hydrological analysis shows improvements in the upstream planning reaches to have little effect in this area, indicating that a local solution would be most effective.

In addition, an open channel was sized for this planning reach to provide another basis for evaluating the upstream improvements, but the channel is not considered a viable option. This option will be a sub-part of the Plan for reach PR-1.

REACH PRI-2: Inadvertent detention and overtopping of State Highway 2 would be avoided with enlargement of the existing culvert at that location. The site's topography does not lend itself to maximizing detention storage. Erosion control structures are included for the upstream channels in this reach.

The inadvertent detention which occurs upstream of railroad tracks within the Arsenal at 72nd Ave., (7th Ave. and B St.), will be maximized to a volume of 330 a.f.

Channels in this reach are sized and costs estimated for trapezoidal, sandy bottom channels with overbank flow areas.

REACH PRI-3: Provide embankment, spillway and outlet repairs to meet minimum SEO standards for Lower Derby, and Ladora Lake. Additional storage benefits may be realized by improvements to the spillways to maximize flood control. Provide embankment, spillway and outlet repairs to Upper Derby and lower the normal maximum water surface (NMWS) by five feet to increase flood storage to 360 a.f. The NMWS would be lowered by changing the elevation of the uncontrolled spillway, but would not require excavation of the reservoir area.

Upper Derby in conjunction with Havana Pond can be used to divert water to other areas of the RMA for surface water management.

REACH PRI-4: Incorporate the inadvertent detention that occurs upstream of Highway 2 at design point 78 and 81. The railroad embankment effectively blocks the runoff from reaching the downstream Commerce City area, but Highway 2 will be overtopped during minor events since the embankment is generally only four to five feet high. The detention capabilities upstream of Highway 2 will be maximized so as to detain 101 a.f. at design point 78.
The current clean-up plans call for the removal of Basins C, D, E & F, with Basin F in the clean-up stages as of the date of this report. The areas are to be restored to natural conditions. The increased runoff from these areas due to the elimination of the storage will therefore be insignificant.

REACH PRI-5: Havana Pond will be improved to maximize storage by providing embankment, spillway and outlet modifications. The resulting detention facility will be capable of storing 486 a.f. before overtopping. Provide erosion control structures and road crossing improvements. Culverts at dirt roads and paved major roads will be sized for 100-year flood protection. Channels in this reach are projected to be trapezoidal with sandy bottom with overbank flow areas.

REACH PRI-6: Provide erosion control structures and road crossing improvements. Culverts at dirt roads and paved major roads will be sized for 100-year flood protection. Channels in this reach are projected to be trapezoidal with sandy bottom with overbank flow areas.

REACH PRI-7: The improvements in this reach will be evaluated individually

and with mini-regional detention in the upper undeveloped areas of Irondale Gulch.

PLAN 2

RESERVOIR IMPROVEMENTS AND INCREASED DETENTION (REFER TO DRAWING 10B)

REACH PRI-1: This plan incorporates the recommendations from the McLaughlin master plan for the Commerce City area. Hydrological analysis shows improvements in the upstream planning reaches to have little effect in this area, indicating that a local solution would be most effective.

In addition, an open channel was sized for this planning reach to provide another basis for evaluating the upstream improvements, but the channel is not considered a viable option. This option will be a sub-part of the Plan for reach PR-1.

REACH PRI-2: Inadvertent detention and overtopping of State Highway 2 would be avoided with enlargement of the existing culvert at that location. The site's topography does not lend itself to maximizing detention storage. Erosion control structures are included for the upstream channels in this reach.

The inadvertent detention which occurs upstream of railroad tracks within the Arsenal at 72nd Ave., (7th Ave. and B St.), will be maximized to a volume of 330 a.f.

Channels in this reach are sized and costs estimated for trapezoidal, sandy bottom channels with overbank flow areas.

REACH PRI-3: Provide embankment, spillway and outlet repairs to meet minimum SEO standards for Lower Derby and Ladora Lake. Provide embankment, spillway and outlet repairs to Upper Derby and lower the normal maximum water surface (NMWS) by five feet to increase flood storage. The NMWS would be lowered by changing the elevation of the uncontrolled spillway. Excavate additional storage area from the existing contours to the lowered NMWS to provide an additional 118 a.f. and a total volume of 478 a.f. Because of the potential contamination of the excavated material, mitigation and proper material disposal are included in the plan. Upper Derby and Havana Pond can be used to divert water to other ares of the RMA for surface water management.

REACH PRI-4: Incorporate the inadvertent detention that occurs upstream of Highway 2 at design point 78 and 81. The railroad embankment effectively blocks the runoff from reaching the downstream Commerce City area, but Highway 2 will be overtopped during minor events since the embankment is generally only four to five feet high. The detention capabilities upstream of Highway 2 will be maximized so as to detain 101 a.f. at design point 78.

The current clean-up plans call for the removal of Basins C, D, E & F, with

Basin F in the clean-up stages as of the date of this report. The areas are to be restored to natural conditions. The increased runoff from these areas due to the elimination of the storage will therefore be insignificant.

REACH PRI-5: Havana Pond will be improved to maximize storage by providing embankment, spillway and outlet modifications. The resulting detention facility will be capable of storing 486 a.f. before overtopping. Provide erosion control structures and road crossing improvements. Culverts at dirt roads and paved major roads will be sized for 100-year flood protection. Channels in this reach are projected to be trapezoidal with sandy bottom with overbank flow areas.

REACH PRI-6: Provide erosion control structures and road crossing improvements. Culverts at dirt roads and paved major roads will be sized for 100-year flood protection. Channels in this reach are projected to be trapezoidal with sandy bottom with overbank flow areas.

REACH PRI-7: The improvements in this reach will be evaluated individually and with mini-regional detention in the upper undeveloped areas of Irondale Gulch.

PLAN 3

PARTIAL DIVERSION FROM ARSENAL AREA (REFER TO DRAWING 10C)

REACH PRI-1: This plan incorporates the recommendations from the McLaughlin master plan for the Commerce City area. Hydrological analysis shows improvements in the upstream planning reaches to have little effect in this area, indicating that a local solution would be most effective.

In addition, an open channel was sized for this planning reach to provide another basis for evaluating the upstream improvements, but the channel is not considered a viable option. This option will be a sub-part of the Plan for reach PR-1.

REACH PRI-2: Inadvertent detention and overtopping of State Highway 2 would be avoided with enlargement of the existing culvert at that location. The site's topography does not lend itself to maximizing detention storage. Erosion control structures are included for the upstream channels in this reach.

The inadvertent detention which occurs upstream of railroad tracks within the Arsenal at 72nd Ave., (7th Ave. and B St.), will be maximized to a volume of 330 a.f.

Channels in this reach are sized and costs estimated for trapezoidal, sandy bottom channels with overbank flow areas.

REACH PRI-3: Provide embankment, spillway and outlet repairs to meet minimum

SEO standards for Lower Derby, and Ladora Lake. Additional storage benefits may be realized by improvements to the spillways to maximize flood control. Provide embankment, spillway and outlet repairs to Upper Derby and lower the normal maximum water surface (NMWS) by five feet to increase flood storage to 360 a.f. The NMWS would be lowered by changing the elevation of the uncontrolled spillway, but would not require excavation in the reservoir area. Upper Derby in conjunction with Havana Pond can be used to divert water to other areas of the RMA for surface water management.

REACH PRI-4: Incorporate the inadvertent detention that occurs upstream of Highway 2 at design point 78 and 81. The railroad embankment effectively blocks the runoff from reaching the downstream Commerce City area, but Highway 2 will be overtopped during minor events since the embankment is generally only four to five feet high. The detention capabilities upstream of Highway 2 will be maximized so as to detain 101 a.f. at design point 78.

The current clean-up plans call for the removal of Basins C, D, E & F, with Basin F in the clean-up stages as of the date of this report. The areas are to be restored to natural conditions. The increased runoff from these areas due to the elimination of the storage will therefore be insignificant.

REACH PRI-5: Provide diversion structures at design points 13, 14 and 74 (RMA boundary) to divert up to the 10-year flood to Sand Creek through the Stapleton Airport redevelopment area. A 50 a.f. detention facility is to be associated with the diversion to reduce channelization costs. The detention pond would be located in the Stapleton Airport redevelopment area. Culvert improvements would be required at Interstate 70 to allow flows to reach Sand Creek. Havana Pond will require only minimal improvements to the embankment, spillway and outlet structure due to the upstream diversion. The improvements include a diversion structure which will allow for base flows to be delivered to Havana Pond for groundwater recharge and delivery to other parts of the arsenal for surface water management.

REACH PRI-6: Provide erosion control structures and road crossing improvements. Culverts at dirt roads and paved major roads will be sized for 100-year flood protection. Channels in this reach are projected to be trapezoidal with sandy bottom with overbank flow areas.

REACH PRI-7: The improvements in this reach will be evaluated individually and with mini-regional detention in the upper undeveloped areas of Irondale Gulch.

PLAN 4

TOTAL DIVERSION FROM ARSENAL AREA (REFER TO DRAWING 10D)

REACH PRI-1: This plan incorporates the recommendations from the McLaughlin master plan for the Commerce City area. Hydrological analysis shows improvements in the upstream planning reaches to have little effect in this area, indicating that a local solution would be most effective.

In addition, an open channel was sized for this planning reach to provide another basis for evaluating the upstream improvements, but the channel is not considered a viable option. This option will be a sub-part of the Plan for reach PRI-1.

REACH PRI-2: Inadvertent detention and overtopping of State Highway 2 would be avoided with enlargement of the existing culvert at that location. The site's topography does not lend itself to maximizing detention storage. Erosion control structures are included for the upstream channels in this reach.

The inadvertent detention which occurs upstream of railroad tracks within the Arsenal at 72nd Ave., (7th Ave. and B St.), will be maximized to a volume of 330 a.f.

Channels in this reach are sized and costs estimated for trapezoidal, sandy bottom channels with overbank flow areas.

REACH PRI-3: Provide minimal embankment, spillway and outlet repairs to meet minimum SEO standards for Upper Derby, Lower Derby, Ladora Lake and Havana Pond. All four lake improvements will reflect the reduced flood peaks due to the upstream diversion. Derby Lake and Upper Derby Lake will be maintained at their current NMWS. Havana pond storage capacity will be maintained at its present 40 a.f. volume. The latter two ponds may be used to divert water to other areas of the RMA for the Clean-Up effort.

REACH PRI-4: Incorporate the inadvertent detention that occurs upstream of Highway 2 at design point 78 and 81. The railroad embankment effectively blocks the runoff from reaching the downstream Commerce City area, but Highway 2 will be overtopped during minor events since the embankment is generally only four to five feet high. The detention capabilities upstream of Highway 2 will be maximized so as to detain 101 a.f. at design point 78.

The current clean-up plans call for the removal of Basins C, D, E & F, with Basin F in the clean-up stages as of the date of this report. The areas are to be restored to natural conditions. The increased runoff from these areas due to the elimination of the storage will therefore be insignificant.

REACH PRI-5: Provide diversion structures at design points 40, 13, 14 and 74 (RMA boundary) to divert up to the 10-year flood to Sand Creek through the Stapleton Airport redevelopment area. A 160 a.f. detention facility is to be associated with the diversion to reduce channelization costs. The detention pond would be located in the Stapleton Airport redevelopment area. Culvert improvements would be required at Interstate 70 to allow flows to reach Sand Creek. Havana Pond will require only minimal improvements to the embankment, spillway and outlet structure due to the upstream diversion. The improvements include a diversion structure which will allow for base flows to be delivered to Havana Pond for groundwater recharge and delivery to other parts of the arsenal for the clean up activities.

REACH PRI-6: Provide diversion structures at design points 66, 50, 48, and 51 (RMA boundary) to divert up to the 10-year flood to Sand Creek through the Stapleton Airport redevelopment area. Upper Derby will require only minimal improvements to the embankment, spillway and outlet structure due to the upstream diversion. The improvements include a diversion structure which will allow for base flows to be delivered to Upper Derby for groundwater recharge and delivery to other parts of the arsenal for the clean up activities.

REACH PRI-7: The improvements in this reach were evaluated individually and with mini-regional detention in the upper undeveloped areas of Irondale Gulch.

MINI-REGIONAL DETENTION OPTION FOR PRI-7 (REFER TO DRAWING 10A)

Planning Reach 7 encompasses the uppermost reaches of Irondale Gulch Basin. This reach is developed in its downstream section (Montbello), and largely undeveloped upstream of Chambers Road.

Two mini-regional detention plans were developed for the upper Irondale Gulch watershed (ie: upstream of Chambers Road). Plan PRI-7(A) incorporates detention in the area immediately upstream of the Airport Boulevard and includes the proposed detention in Parkfield and the Aurora Business Center (can be onsite detention) and the existing detention in Green Valley Ranch. Plan PRI-7B is similar to Plan PRI-7A but incorporates additional detention at Chambers Road to further reduce the impact of future development on the Montbello area.

PLAN PRI-7(A)

At the proposed Airport Blvd. (currently Buckley Road), there are four tributaries in PR-7. Each tributary is to have a detention facility to effectively reduce the impact of increased runoff peaks and volumes on the Montbello storm drainage infrastructure. The four detention facilities are as follows:

DETENTION ELEMENT	LOCATION	NAME	VOLUME
210	DP 66	Parkfield	60 AF
211	DP 70	Silverado 1	34 AF
212	DP 59	Silverado 2	78 AF
213	DP 35, D/S	Upland	11 AF

The improvements in Montbello consist of concrete channels, culvert improvements and storm sewers. Improvements are selected on and individual reach basis necessary to achieve a area wide 2-, 5- or 10-year flood protection level for the minor storm system. The residual 100-year flood would be carried in the streets up to the allowable limits for Denver (ie: 12" depth at the flow-line). In general, the residual 100-year flow can be

carried in the street when the minor storm system has capacity for the 10-year flood.

PLAN PRI-7(B)

The proposed detention facilities for this plan include the four sites in Plan-7(A) plus two additional sites as follows:

DETENTION ELEMENT	LOCATION	NAME	VOLUME
210	DP 66	Parkfield	60 AF
211	DP 70	Silverado 1	34 AF
212	DP 59	Silverado 2	78 AF
213	DP 35, D/S	Upland	11 AF
215	DP 57	Chambers 1	67 AF
216	DP 33	Chambers 2	34 AF

The improvements in the Montbello area also consists of concrete channel, culvert enlargements and storm sewers and are selected on an individual reach basis to achieve a 2-, 5- or 10-year flood protection.

The goal for this plan was to provide sufficient detention such that the existing development conditions flood peaks for the 10- and 100-year flood are not exceeded. This would reduce the costs for the local Montbello facilities to achieve uniform flood protection.

3. First Creek

The development of storm drainage alternatives in the First Creek Basin are divided into two categories; detention pond combinations and selected channel types. The goals which were pursued in siting and sizing detention facilities are as follows:

(a) Maintain developed stormwater peak flows at or below existing levels, particularly across the Rocky Mountain Arsenal (RMA).

(b) Develop feasible and cost effective plans that can be implemented with phased development.

(c) Protect sensitive wildlife habitat and RMA clean up areas including groundwater regimes.

(d) Maintain flexibility in stormwater routing and storage to aid in surface water management and clean-up activities on the Rocky Mountain Arsenal.

(e) Site facilities at locations which take advantage of proposed open space, transportation rights-of-way and existing topography.

(f) Investigate additional detention options within the Aurora annexation study area to meet the goals and objectives defined herein.

Five detention facility plan combinations were selected. These detention alternatives may be included with any of the alternative channel sections investigated for each reach. The detention plans are:

Plan 1 Green's Reservoir, Airport Boulevard and Airport Boulevard North (GR+AB+ABN)

Plan 2 Henderson Hill and Airport Boulevard North (HH+ABN)

Plan 3 Developer's Alternative sites 1 & 2 and Airport Boulevard North (DA+ABN)

Plan 4 Modifications to the detention areas within the Aurora annexation area and inclusion of a new site at Picadilly Road

Plan 5 Combination of the above, referred to as WWE Plan

The various detention sites are shown on Drawing 9A & 9B. The combinations of detention facilities investigated and adopted as plans are presented in Table V-3. The aforementioned detention plans were modelled and "fine tuned" to best meet the goals previously described. The SWMM output produced peak flows for each detention plan. Only plans 1, 2, 3 and 5 met the goals defined above. Plan 4, modifications to the Aurora annexation study detention sites, was not sufficient by itself to reduce flood peaks to acceptable levels. However, the modifications were found to be effective when combined with Green's Reservoir, which was used to define Plan 5, called the WWE Plan.

The costs of the above five plans were then evaluated for just the required detention facility. Since most of the detention alternatives met the above goals, then the cost of the facility became a way to select an alternative detention scheme. A cost summary for each of the plans is presented in Table V-4. As can be seen from the Table, Greens Reservoir (Plan 1) is the least expensive of the initial three plans which met the goals. Therefore, Greens reservoir was included in the WWE plan (Plan 5) representing the best combination of all alternatives.

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TABLE V-1A

PLANNING REACH	DESCRIPTION	JURIS-DICTION	FUTURE LAND USE	POTENTIAL FLOOD HAZARDS	STATUS QUO FLOOD PLAIN MANAGEMENT	ENGINEERED FLOODWAY IMPROVEMENTS	SELECTED STRUCTURAL IMPROVEMENTS	"NATURAL" OPEN SPACE CONVEYANCE	ENGINEERED GRASS/WETLAND CHANNEL	ENGINEERED HARD LINED CHANNEL	REGIONAL DETENTION	BASIN WIDE RETENTION	OTHER
PRF-1 (MAIN)	S.P.R. CONFLUENCE TO U/S 85 (D/S)	COMMERCE CITY	FLOODPLAIN, INDUSTRIAL RESIDENTIAL	S.P.R. FLOODPLAIN, LACK OF CHANNEL, OVERBANK FLOODING	YES (WITH U/S BASE FLOW CNTRL)	YES	YES CONSTRUCT MAIN CHANNEL	YES CREATE DRAINAGE PARK	YES AREA IN S.P.R. FLOODPLAIN	NO ADEQ. ROW FOR GRASS CHANNEL	NO S.P.R. FLOODPLAIN	NO FOR TRIBUTARIES ONLY	
PRF-2 (MAIN)	U/S 85 (U/S) TO B.N. RAILROAD (D/S)	COMMERCE CITY	FLOODPLAIN, INDUSTRIAL	LACK OF CHANNEL, OVERBANK FLOODING, BREACHING OF CANALS	NO PRIV. PROP. DAMAGE	YES	YES CANAL STRUCTURE STRT CROSSING	NO INADEQUATE ROW	YES	YES	NO HIGH VALUED PROPERTY	NO FOR TRIBUTARIES ONLY	
PRF-3 (MAIN)	B.N. RAILROAD (U/S) TO 96TH AVE AT RMA (D/S)	COMMERCE CITY	FLOODPLAIN, INDUSTRIAL	LACK OF CHANNEL, OVERBANK FLOODING CHNL EROS, STRT DAMAGE	YES (WITH U/S BASE FLOW CNTRL)	YES	YES B.N.R.R. AND HWY 2	YES	YES	NO ADEQUATE ROW FOR GRASS CHNL	NO INADEQUATE VOLUME (*)	NO FOR TRIBUTARIES ONLY	
PRF-4 (MAIN)	96TH AVE AT RMA (U/S) TO TRIB FR-3 CONFL (DP 14)	RMA	OPEN SPACE	CHANNEL EROSION HABITAT DAMAGE CLEAN-UP IMPACT	YES (WITH U/S BASE FLOW CNTRL)	NO HABITAT IMPACT	YES 96th AVENUE LOCALIZED	NO IMPACT ON CLEAN-UP	NO HABITAT IMPACT, NO DEVELOPMENT	NO HABITAT IMPACT, NO DEVELOPMENT	YES (DIVERT TO REACH PRF-12)	NO FOR TRIBUTARIES ONLY	DIVERT FLOWS TO DETENTION
PRF-5 (MAIN)	TRIB FR-3 CONFL (DP 14) TO TRIB FR-5 CONFL (DP 38)	RMA	OPEN SPACE	CHANNEL EROSION CLEAN-UP IMPACT FACILITIES FLOODING	YES (WITH U/S BASE FLOW CNTRL)	NO NO DEVELOPMENT	YES STRT CROSSING, CHNL EROS CNTRL	NO IMPACT ON CLEAN-UP	NO NO DEVELOPMENT	NO NO DEVELOPMENT	NO INADEQUATE VOLUME	NO FOR TRIBUTARIES ONLY	DIVER. POINT FOR REACH PRF-4
PRF-6 (MAIN)	TRIB FR-5 CONFL (DP 38) TO TRIB FL-5 (D/S) (DP 51)	ADAMS COUNTY	MIXED USE, M.D. RESID.	CHNL EROS, STRT DAMAGE, OVERBANK FLOODING HABITAT DAMAGE	YES (WITH U/S BASE FLOW CNTRL)	NO HABITAT IMPACT	YES STRT CROSSING, CHNL EROS CNTRL	YES	NO HABITAT IMPACT	NO HABITAT IMPACT ADEQUATE ROW	NO HABITAT IMPACT	NO FOR TRIBUTARIES ONLY	
PRF-7 (MAIN)	TRIB FL-5 (D/S) (DP 51) TO PICADILLY ROAD (DP 76)	DENVER	BUSINESS, M.D. RESID.	CHNL EROS, STRT DAMAGE, OVERBANK FLOODING HABITAT DAMAGE	YES (WITH U/S BASE FLOW CNTRL)	NO HABITAT IMPACT	NO HAZARDS NOT LOCALIZED	YES (SUB-REACH ONLY)	YES SUB-REACH ONLY	NO ADEQUATE ROW FOR GRASS CHNL	NO INADEQ. VOLUME HABITAT IMPACT	NO FOR TRIBUTARIES ONLY	
PRF-8 (MAIN)	PICADILLY ROAD (DP 76) TO STUDY LIMITS (AURORA)	AURORA	FLOODPLAIN, MIXED USE	CHANNEL EROSION OVERBANK FLOODING STREET DAMAGE	YES (WITH U/S BASE FLOW CNTRL)	SEE SLA REPORT	SEE SLA REPORT	SEE SLA REPORT	SEE SLA REPORT	SEE SLA REPORT	YES ENLARGEMENT OR RELOCATION	NO FOR TRIBUTARIES ONLY	

FIRST CREEK MASTER ALTERNATIVE MATRIX

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PLANNING REACH	DESCRIPTION	JURISDICTION	FUTURE LAND USE	POTENTIAL FLOOD HAZARDS	STATUS QUO FLOOD PLAIN MANAGEMENT	ENGINEERED FLOODWAY IMPROVEMENTS	SELECTED STRUCTURAL IMPROVEMENTS	"NATURAL" OPEN SPACE CONVEYANCE	ENGINEERED GRASS/WETLAND CHANNEL	ENGINEERED HARD LINED CHANNEL	REGIONAL DETENTION	BASIN WIDE RETENTION	OTHER
PRF-9 (TRIB FR-6)	TRIB FR-6 CONFL (DP 64) TO PICADILLY ROAD (DP 80)	DENVER	BUSINESS, M.D. RESID.	CHNL EROS, STRT DAMAGE, OVERBANK FLOODING HABITAT DAMAGE	YES (WITH U/S BASE FLOW CNTRL)	NO HABITAT IMPACT	YES EROSION CONTROL	YES	YES	NO ADEQUATE ROW FOR GRASS CHNL	NO INADEQ. VOLUME HABITAT IMPACT	YES	
PRF-10 (TRIB FR-6)	PICADILLY ROAD (DP 80) TO STUDY LIMITS (AURORA)	AURORA	FLOODPLAIN, MIXED USE, RESIDENT.	CHANNEL EROSION OVERBANK FLOODING STREET DAMAGE	YES (WITH U/S BASE FLOW CNTRL)	SEE SLA REPORT	SEE SLA REPORT	SEE SLA REPORT	SEE SLA REPORT	SEE SLA REPORT	YES ENLARGEMENT OR RELOCATION	YES	
PRF-11 DFA AREA	US-85 TO B.N. RAILROAD	ADCO C. CITY RMA	FLOODPLAIN, INDUSTRIAL	STREET DAMAGE, CANALS BREACHED, SHALLOW FLOODING	NO NO DEFINED CHANNEL	NO NO DEFINED CHANNEL	YES CANALS, STREETS	NO NO DEFINED CHANNEL	YES	YES	NO INADEQUATE VOLUME	YES	MINOR STORM SEWER AND STREET SYSTEM
PRF-12 (FR-2,3,4 / FL-2,3,4)	TRIB FR-3 CONFL (DP 14) TO TOWER RD (DP 24,25,33)	RMA ADAMS COUNTY	OPEN SPACE RESIDENTIAL	CHNL EROS, STRT DAMAGE, CLEAN-UP IMPACT FACILITIES FLOODING	YES (WITH U/S BASE FLOW CNTRL)	NO MINIMAL U/S DEVELOPMENT	YES STRT CROSSING EROSION CONT.	NO MINIMAL U/S DEVELOPMENT	YES DIVERSION TO DETENTION	NO MINIMAL U/S DEVELOPMENT	YES	YES	LOCAL OR ONSITE DETENTION W/LINING
PRF-13 (TRIB FR-5)	TRIB FR-5 CONFL (DP 38) TO PICADILLY RD (DP 45)	DENVER	MIXED USE, E-470 CORR.	CHNL EROS, STRT DAMAGE, TRAILER RES. DAMAGE HABITAT DAMAGE	YES (WITH U/S BASE FLOW CNTRL)	YES	YES STRT CROSSING EROSION CONT.	NO MINIMAL U/S DEVELOPMENT	YES	NO ADEQUATE ROW FOR GRASS CHNL	YES	YES	LOCAL OR ONSITE DETENTION
PRF-14 (TRIB FL-5)	TRIB FL-5 CONFL (DP 54) TO DESIGN POINT 82	DENVER	M.D. RESID. MIXED USE	CHANNEL EROSION OVERBANK FLOODING STREET DAMAGE	YES (WITH U/S BASE FLOW CNTRL)	NO EXIST. URBAN AREA	YES STRT CROSSING EROSION CONT.	NO EXIST URBAN AREA	YES	NO ADEQUATE ROW FOR GRASS CHNL	NO SMALL TRIB. AREA	NO SMALL TRIB. AREA	MINOR STORM SEWER AND STREET SYSTEM

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PLANNING REACH	DESCRIPTION	JURISDICTION	FUTURE LAND USE	POTENTIAL FLOOD HAZARDS	STATUS QUO FLOOD PLAIN MANAGEMENT	ENGINEERED FLOODWAY IMPROVEMENTS	SELECTED STRUCTURAL IMPROVEMENTS	"NATURAL" OPEN SPACE CONVEYANCE	ENGINEERED GRASS/WETLAND CHANNEL	ENGINEERED HARD LINED CHANNEL	REGIONAL DETENTION	BASIN WIDE RETENTION	OTHER
PRF-15, FR-6A, 6B, & 6C	DP 62-69, DP 65-71, AND DP 69-73	AURORA	M.D. RESID. MIXED USE	CHANNEL EROSION OVERBANK FLOODING STREET DAMAGE	YES (WITH U/S BASE FLOW CNTRL)	NO SMALL TRIB. AREA	YES STRT CROSSING EROSION CONT.	NO SMALL TRIB. AREA	YES	NO ADEQUATE ROW FOR GRASS CHNL	NO SMALL TRIB. AREA	YES	MINOR STORM SEWER AND STREET SYSTEM

DESCRIPTION OF IMPROVEMENTS

1. STATUS QUO, FLOODPLAIN MANAGEMENT: no improvements, enforce floodplain regulations and encourage flood insurance
2. FLOODWAY IMPROVEMENTS: construct main channel (5-year) and provide overbank conveyance for 100-year flood
3. SELECTED STRUCTURAL IMPROVEMENTS: construct local improvements including bridge/culverts, bank protection, check structures
4. NATURAL OPEN SPACE CONVEYANCE: construct meandering wetland low flow channel around environmentally sensitive main channel, special treatment of check structures.
5. ENGINEERED GRASS/WETLAND CHANNEL: construct main channel (10-year) with wetland bottom or sand bottom, provide overbank conveyance for 100-year flood, aesthetically treated check structures.
6. ENGINEERED HARD LINED CHANNELS: construct 100-year hard lined channel using riprap or concrete.
7. REGIONAL DETENTION: construct normally dry detention which controls minor and major floods for regional benefits
8. BASIN WIDE RETENTION: require all new developments to provide onsite retention of 10-year rainfall from impervious surfaces, for minor storms only.
9. MINOR DRAINAGEWAY STORM SEWER AND STREET CONVEYANCE: provide storm sewer/street system to convey 5-year minor flood and 100-year flood in ROW.

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TABLE V-2

	PLAN 1 (max utilization)	PLAN 2 (enlarge system)	PLAN 3 (part. diversion)	PLAN 4 (full diversion)	PLAN 5 (Plan 1 + u/s deten)
UPPER DERBY	REHABILITATION TO SEO SPECS	ENLARGEMENT TO MAXIM. STORAGE	ENLARGEMENT TO MAXIM. STORAGE	MINIMAL REHABILITATION	REHABILITATION TO SEO SPECS
LOWER DERBY	REHABILITATION TO SEO SPECS	REHABILITATION TO SEO SPECS	REHABILITATION TO SEO SPECS	MINIMAL REHABILITATION	REHABILITATION TO SEO SPECS
LADORA LAKE	REHABILITATION TO SEO SPECS	ENLARGEMENT TO MAXIM. STORAGE	REHABILITATION TO SEO SPECS	MINIMAL REHABILITATION	REHABILITATION TO SEO SPECS
HAVANA POND	REHABILITATION TO SEO SPECS	REHABILITATION TO SEO SPECS	MINIMAL REHABILITATION	MINIMAL REHABILITATION	REHABILITATION TO SEO SPECS
RAILROAD DETEN.	PROVIDE SPILLWAY CAPACITY	PROVIDE SPILLWAY CAPACITY	PROVIDE SPILLWAY CAPACITY	PROVIDE SPILLWAY CAPACITY	PROVIDE SPILLWAY CAPACITY
MARY LAKE	PROVIDE SPILLWAY CAPACITY(*)	PROVIDE SPILLWAY CAPACITY	PROVIDE SPILLWAY CAPACITY	PROVIDE SPILLWAY CAPACITY	PROVIDE SPILLWAY CAPACITY

DEFINITION OF TERMS

1. REHABILITATION TO SEO SPECS: provide embankment, spillway, and outlet repairs to meet minimum SEO standards

2. ENLARGEMENT TO MAXIMUM CAPACITY: maximize volume by enlarging embankment, spillway, and outlet works

3. MINIMAL REHABILITATION: provide embankment, spillway and/or outlet improvements for a lesser drainage area

4. PROVIDE SPILLWAY CAPACITY: improve outlet pipe to prevent overtopping of embankment

NOTES

(*) The required spillway capacity will vary depending on the detention in the upper reservoirs

IRONDALE GULCH ALTERNATIVE-STATUS OF RMA DETENTION AREAS

TABLE V - 3

SELECTED DETENTION SITES FOR EVALUATION
FIRST CREEK ALTERNATIVES

ELEMENT	LOCATION	NAME	VOLUME
202	DP 32, BUCKLEY ROAD,	AIRPORT BLVD, NORTH (ABN)	53 AF
N/A	DP 10, SECT 19 RMA	HENDERSON HILL (HH)	1130 AF
201	DP 41, AIRPRT. BLVD	AIRPORT BLVD (AB)	243 AF
200	DP 38, 64th/BUCKLEY	GREEN'S RESVR (GR)	1100 AF
205	DP 48, 56th/AIRPRT B.	DEVLPR'S ALTRN 1 (DA1)	587 AF
206	DP 49, 56th/TOWER	DEVLPR'S ALTRN 2 (DA2)	845 AF
N/A	WITHIN AURORA LIMITS	SLA MODIFICATIONS (SLAM)	N/A

NOTES:

1. SLA Modifications refers to the WWE outlet modifications of the detention sites proposed by SLA, Inc. in the annexation report, including the Picadilly detention site.
2. Plan 1, Green's Reservoir includes: GR and ABN sites
3. Plan 2, Henderson Hill includes: AB, ABN and HH sites
4. Plan 3, Developer's Alternative includes: AB, ABN, DA1 and DA2
5. Plan 4, SLA Modifications includes outlet modifications to ponds A, B, C, T MOD1 and T MOD2 and the Picadilly site
6. Plan 5, WWE Plan includes: GR, ABN, outlet modifications to ponds A, B, C, T MOD1 and T MOD2 and the Picadilly site
7. All plans include the detention sites within the Aurora area, recommended by the SLA, Inc. report.

TABLE V -4

COST COMPARISON OF DETENTION ALTERNATIVES
FIRST CREEK

DESIGN POINT	TITLE	PLAN 1 GREENS RSVR.	PLAN 2 HENDERSON HILL	PLAN 3 DEVELOP. ALTERN. SITES	PLAN 4 SLA MODS.	PLAN 5 WWE PLAN
200	GREENS	9,135,600				9,135,600
201	AIRPORT		1,353,700	1,353,700		
202	AIRPORT N.	405,100	405,100	405,100		405,100
203	PICADILLY				1,555,600	1,555,600
204	HENDERSON		4,938,000			
205	DEV.OPT. 1			4,901,000		
206	DEV.OPT. 2			6,809,200		
225	POND A MOD				42,000	42,000
227	POND B MOD				42,000	42,000
237	POND C MOD				42,000	42,000
260	TRIB T MOD 1				42,000	42,000
262	TRIB T MOD 2				42,000	42,000
TOTALS		9,540,700	6,696,800	13,469,000	1,758,600	11,299,300
ADDITIONAL COSTS:						
	HENDERSON DIVR		9,095,100			
GRAND TOTALS		**$9,540,700**	**$15,791,900**	**$13,469,000**	**$1,758,600**	**$11,299,300**

NOTE: 1. Plan 4, SLA modifications does not meet the flood peak reduction goals set forth for the project and is therefore not an acceptable detention alternative by itself.

2. All plans include the detention sites within the Aurora area, recommended by the SLA, Inc. report.

SECTION VI

EVALUATION

OF

ALTERNATIVES

SECTION - VI

EVALUATION OF ALTERNATIVES

A. HYDRAULIC EVALUATION

1. Irondale Gulch

The various improvement alternatives were hydraulically evaluated by modelling the facilities using the routing routine in the SWMM computer program. The four plans in lower Irondale Gulch are as follows: Plan 1, Maximum Utilization of Existing Facilities; Plan 2, Reservoir Improvements and Increased Detention; Plan 3, Partial Diversion from the Arsenal Area; and Plan 4, Total Diversion from the Arsenal Area.

The alternatives in upper Irondale Gulch included two mini-regional detention plans in the area upstream of Montbello (planning reach PRI-7), in addition to a detailed evaluation of the smaller channel reaches in the Montbello area. Both of the two plans were also modelled to determine the reduction of flood peaks in the Montbello area and the RMA.

Because of the local runoff contribution within Montbello, the benefits of detention in the upper reaches of Irondale Gulch were minimal at the south boundary of the RMA. Figure VI-7 shows the impacts of the both detention plans in upper Irondale Gulch on the flood peaks in Commerce City and the RMA. Since the flood peak differences are muted by the reservoirs on the RMA, the hydraulic impact of detention in upper Irondale was considered to have minimal impact. However, some differences in the costs with and without the upper Irondale detention was noted. Therefore, the four alternative plans in lower Irondale Gulch were considered to be essentially independent of the two alternative plans in upper Irondale Gulch.

The hydraulic modelling included modifications of existing detention facilities, addition of new detention facilities, changes in conveyance element slopes, and changes in the routing of runoff. In general, detention modifications were targeted at reducing flood peaks to the capacity of the existing downstream facilities or to match existing development conditions flood peak in the downstream reaches, whichever was less.

Detention was sized in two ways. At sites where physical conditions limited storage volume, storage-discharge information for the SWMM model was developed by selecting an outflow hydrograph which matched the capacity of the downstream facilities, when applied to the inflow hydrograph of a design point representative of the detention site. This method was used for the Arsenal detention sites and for the Montbello sites where specific volume information was available.

The second method was applied to situations where physical limitations were minimum and where discharge control was paramount. Here, the desired outflow hydrograph (again, targeting reduction of the peak to existing channel, culvert, or storm sewer capacity) was compared with the inflow hydrograph of a

representative design point and the difference between inflow and outflow over time determined the necessary storage volume. This method was applied to sites in upper Irondale Gulch and at railroad crossings in the Rocky Mountain Arsenal.

Channel slopes were reduced to decrease flow velocity. These changes were made in the SWMM conveyance routing model. Alternative plans 3 and 4 for lower Irondale Gulch involved diversion of flows along 56th Avenue to Sand Creek. These changes were made by altering the routing of the SWMM model or, where the model could not be adapted, were calculated manually.

The resulting flood peaks of each alternative were then tabulated and graphs of the flood peak profile were generated. These results are presented in the following tables and figures:

LOCATION OF PEAK FLOW DATA
IRONDALE GULCH

LOCATION	PLAN	FREQUENCY	TABLE
LOWER IRONDALE	1 TO 4	ALL	VI-1A TO VI-1B
UPPER IRONDALE	1 & 2	ALL	VI-2A TO VI-2B

LOCATION	PLAN	FREQUENCY	FIGURE
LOWER IRONDALE	1 TO 4	2-YEAR	VI-1
LOWER IRONDALE	1 TO 4	100-YEAR	VI-2
UPPER IRONDALE	1 & 2	2-YEAR	VI-3
UPPER IRONDALE	1 & 2	100-YEAR	VI-4

In general, the figures illustrate the effectiveness of detention facilities (indicated by sharp drops in the peak flows), points of tributary confluence (indicated by sharp rises in the peak flows) and the relative effectiveness of each plan to the other plans and to the existing conditions.

The series of figures in IV-1A and IV-1B (without mini-regional detention) may be compared to the series of figures in IV-2A and IV-2B (with mini-regional detention) to evaluate the effect of the detention facilities in Planning Reach 7. These detention facilities do not effect peak flows downstream of Ladora Lake and therefore the series IV-2A and IV-2B figures do not show peak flow reductions in the Commerce City area.

2. First Creek

Evaluation of First Creek alternatives centered around comparison of the effects of various detention scenarios on reducing flood peaks to existing levels and capacities in order to develop the combination of facilities which is most cost effective. The detention site combinations considered were as follows:

Plan 1 Detention at Green's Reservoir and the northern Airport Boulevard Corridor

Plan 2 Diversion from First Creek to detention at Henderson Hill with detention in the north and south sections of the Airport Boulevard Corridor

Plan 3 Developers' option, designed to have the same hydraulic effect as Plan 1, with ponds located upstream of the Arsenal and at the north and south sections of the Airport Boulevard Corridor.

Plan 4 Modification of the detention sites in the Aurora Annexation study area.

Plan 5 Combination of the best detention options, (referred to as the WWE plan). This plan consists of Green's Reservoir, the north Airport Boulevard detention, the modification of detention in the Simons, Li & Associates Master Plan and the addition of Picadilly detention.

Other detention possibilities investigated but found to be ineffective include detention downstream of the RMA in planning reach PRF-3. The site was found to have insufficient storage volume. Also, retention (ie: long term detention for 48-hours) for the developing tributaries east of the RMA was evaluated, but was also found to have insignificant benefits to reduce the flood peaks in the main stem of First Creek. However, retention was found to reduce the flood peaks within the tributary drainageways and was therefor considered a viable alternative when combined with other regional detention options.

In general, detention ponds were sized to reduce flood peaks to the capacity of the existing channel. This was approached in two ways. At sites where physical conditions limited storage volume, storage-discharge information for the SWMM model was generated by choosing an outflow hydrograph which, when applied to the inflow hydrograph of a design point representative of the detention site, peaked at the physical capacity of the site. This method was used for detention sites on the main channel.

The second method was applied to situations where physical limitations were minimum and where discharge control was paramount. Here, the desired outflow hydrograph (again, targeting reduction of the peak to existing channel, culvert, or storm sewer capacity) was compared with the inflow hydrograph of a representative design point and the difference between inflow and outflow over time determined the necessary storage volume. This method was applied to sites on the tributaries.

Modifications to the detention in the Aurora annexation area were evaluated in both ways by targeting specific outflows for the 2-year event without increasing the total storage of the ponds.

The resulting flood peaks of each alternative were tabulated and graphs of the flood peak profile were prepared. These results are presented in the following tables and figures:

LOCATION OF PEAK FLOW DATA
FIRST CREEK

	PLAN	FREQUENCY	LOCATION
TABLE	1 TO 5	ALL	VI-3.i TO VI-3.?
FIGURE	1 TO 5	2-YEAR	VI-5
FIGURE	1 to 5	100-YEAR	VI-6

An evaluation of Figure VI-5 indicates the most effective detention plan for the minor flood is the combination of Green's Reservoir and Airport Boulevard north detention facilities (Plan 1), although the flood peaks are still around 200 cfs higher than existing. Similar benefits are also realized by the Henderson Hill diversion option, Plan 2. The Developer's Option, Plan 3 also substantially reduces flood peaks, but the values are still about twice as great as the existing conditions flood peaks. Finally, the retention in the tributaries only has minimal benefits in the main stem of first creek, which is why retention was eliminated as a viable alternative plan.

Referring to Figure VI-6, a similar comparison of detention site combinations for the 100-year storm may be made. In this case all alternatives, except retention in the tributaries, are able to reduce future flood peaks below existing levels, again which is why retention was eliminated as a viable alternative plan.

Figures VI-5 and VI-6 also show the differences between the detention combinations for the 2-yr and 100-yr design storms when modifications to the proposed Aurora detention sites are incorporated into each plan. Note that none of the detention combinations, except the WWE plan, are able to reduce flood peaks below existing levels for the 2-yr storm. The WWE plan adds the Picadilly detention site and incorporates the best of the other four plans. All the detention plans are effective, however, in reducing the 100-year floodpeaks below existing development levels.

Figure VI-5 also illustrates the effectiveness of modifications made to the outlet release rates for SLA detention facilities to target the 2-yr runoff. The same modifications only have a slight peak flow reduction benefit for the 100-year flood. The 100-year flood storage amounts for the SLA proposed detention facilities were not altered, only the minor flood storage was increased by modifying the outlet works to store more runoff for the minor flood. Therefore, the modifications should be noted as a recommended addition to the SLA study and were included with each of the proposed detention plans during further analysis.

B. SIZING AND COSTING OF ALTERNATIVES

The sizing and estimation of the costs of alternatives develops additional criteria for the evaluation or ranking of those alternatives. The procedure is directed at generating representative costs without designing the system and developing quantity estimates from preliminary design drawings. To do this, general formulas for size and cost were calculated based on typical sections. Generally, the cost of channel improvements increases as the capacity of the channel increases. Therefore, the sizes and costs of channel improvements for each conveyance element were generated using formulas relating flow (Q) and cost (C) or channel width (B). Likewise, the costs for detention facilities were calculated using formulas relating storage volume and cost. The details of this calculation procedure is described below. The unit costs used in the analysis are presetnted in Table VI-8.

1. Drainage Improvements

Channel types were selected and typical sections prepared. For Irondale Gulch, two types of riprap lined, sandy bottom channels were used; one with a trapezoidal main channel ("Simple Trapezoid"), and one with a trapezoidal main channel with an overbank flow area ("Trapezoidal With Overbank"). In the special case of Montbello, where trapezoidal concrete channels are already in place, a special rectangular replacement concrete channel were used. These channels are designated by the letter the City and County of Denver uses to describe the channels they replace.

From these sections, the channel capacities at various slopes, flow depths, and channel widths were calculated and curves relating capacity and channel width were generated. The dimensions of a typical channel along a specific conveyance element could then be selected based on the required Q for that channel for the alternative in question.

From the typical channel sections, the material quantities for given channel dimensions were also determined. The cost per linear foot of each type of channel was then calculated for two different capacities. This established two data points for cost versus flow curves which were then used to calculate channel cost per linear foot. The cost versus capacity values were compared to other projects where the same technique was used.

For the main stem of First Creek, the unit cost of several channel types were included: Engineered Floodway, Engineered Wetland, and Natural Open Space Channels. For the tributaries, the channel types used to prepare unit costs were: Grass Lined, Riprap Lined (the "ST" channel developed for Irondale Gulch), and rectangular concrete channels. Costs were estimated for each of the three main channel alternatives for each channel reach and for one channel type for each tributary reach. Tributary channel type was selected based on slope, flow, and land use considerations. Channel cross-sections were developed, and formulas for the capacity and cost of a channel of a given width were computed.

Drop Structures were also included in the category "Drainage Improvements". For both Irondale Gulch and First Creek, the costs for these structures were calculated using the design procedures presented in the UD&FCD Storm Drainage Criteria Manual. These costs were then entered into the conveyance element summary with the other channel costs.

2. Street Crossings

The street crossing costs versus capacity were determined in generally the same way as for channels with the exception that three different types of crossings were evaluated. For the lower flow range (ie: up to 500 cfs), the street crossing was sized based on concrete pipe culverts with headwalls and wingwalls and with a headwater depth of around 8 feet. Up to 3000 cfs, the street crossing was calculated based on reinforced concrete box culverts, also with a headwater depth around 8 feet. Above 3000 cfs, simple span bridges were used, with a flow depth of 8 feet, but below the low chord of the bridge.

3. Detention Storage

Costs for detention facilities are related to the size of the facility, measured in storage volume. In order to establish the relationship between cost and storage volume, site work costs were estimated for three detention facilities. These estimates served as data points for a curve relating cost per acre foot storage to volume storage. This curve was used to calculate general site work costs for each detention facility.

The cost for the modifications to the five ponds in the Simons, Li & Associates study were calculated specifically for the outlet modification

Land costs were calculated separately for each facility (see below). Special costs, such as PVC bottom lining, were added to those facilities which required additional site work, such as Green's Reservoir. In addition, because of the excavation required to increase the storage volume in Upper Derby lake, mitigation of the potentially contaminated materials was also included in the costs.

4. Utility Relocation

Utility relocations were assumed to occur at street crossings. The total cost for utility relocation was estimated as 20 percent of the total street crossing cost.

5. Land Costs

Land costs were estimated for the acquisition of the entire easement width for channels and for acquisition of the easement area of detention facilities. Land costs of $18,000/acre in the Arsenal reaches are not for acquisition of land per se, but are included as the estimated value of land on Arsenal property.

6. Contingencies, Engineering and Administration

Costs for contingencies, engineering, and administration were calculated as 40 percent of the total of Drainage Improvements, Street Crossings, and Detention Storage costs. This cost reflect the engineering costs associated with designing and constructing the improvements recommended in the Master Plan. This 40 percent is divided further as follows: Contingencies, 20 percent; Engineering and Construction Administration, 15 percent; and Legal/Administrative, 5 percent.

7. Other Consideration and Special Reach Costs

For the portions of Irondale Gulch in Commerce City, WWE used the McLaughlin Master Plan as the base condition and evaluated a 100-year conveyance scheme to carry upstream flows from the RMA to the South Platte River. WWE sized and estimated costs for a simple trapezoidal channel for the main drainageway only. Other costs associated with the local outfall system were not included.

In Aurora, WWE included the previously prepared Simons, Li & Associates Master Plan in the overall master plan for First Creek. For this reason, the master plan costs estimated by Simons, Li & Associates are included in the cost estimates for the First Creek overall master plan. For clarity, the cost of modifications to the Simons, Li & Associates plan recommended by WWE are itemized separately.

8. Cost Summaries

Presented in Tables VI-4 and VI-5 are the cost summaries for each alternative plan for the respective watersheds. The costs are presented by reach and are divided into Drainage Improvements (ie: channels, erosion control, check drops), Street Crossing, Detention Storage, Utility Relocation, Land, and the combination of Contingency/Engineering/Administration.

C. ASSESSMENT PROCEDURE

The alternative evaluation process used by WWE involved the ranking of proposed storm drainage features to provide additional confirmation of the interpretations made of the SWMM model runs and allow for input of environmental, wildlife and aesthetic considerations to the decision process.

In the lower Irondale Gulch watershed, the four proposed plans were evaluated individually using an evaluation matrix. For the First Creek Basin the detention alternative was selected which best met the goals presented in Section V-E.3 and the evaluation matrix was used to select the most appropriate channel type for the given peak flows.

A discussion of the categories used in the evaluation matrix is presented below. The categories in the matrix are identical for both the Irondale Gulch and the First Creek Basins. Refer to Tables VI-6 and VI-7.

For the particular reach in question, the question is asked "Can the proposed drainage alternative (improve, benefit, other) the (evaluation parameter)?". The scale is 1 (little or none) to 5 (highest or best) with the highest number representing the greatest benefit. The wording of the evaluation parameter, presented in the table below, has been made to allow the highest ranking for the best alternative.

EVALUATION PARAMETER

Engineering Considerations

1. IMPROVE THE EXISTING AND POTENTIAL EROSION AND SEDIMENTATION PROBLEM
2. IMPROVE THE FLOODING PROBLEMS OF ADJACENT PROPERTY
3. IMPROVE THE FLOODING PROBLEM OF THE EXISTING OR PROPOSED TRANSPORTATION SYSTEM
4. BE CONSTRUCTED INDEPENDENTLY OF OTHER IMPROVEMENTS AND STILL PROVIDE THE BENEFITS
5. BE CONSTRUCTED AT A REASONABLE COST PER MILE RELATIVE TO THE OTHER OPTIONS
6. BE ADMINISTRATIVELY IMPLEMENTED UNDER NORMAL CONDITIONS
7. BE MAINTAINED AND IF SO, FOR A REASONABLE COST
8. BE CONSTRUCTED WITH MINIMUM ROW REQUIREMENTS

Environmental and Aesthetic Considerations

9. IMPROVE OR MAINTAIN THE STREAM INTACTNESS
10. IMPROVE OR MAINTAIN THE WILDLIFE HABITAT
11. IMPROVE OR ENHANCE VEGETATIVE ENVIRONMENT
12. IMPROVE OR ENHANCE THE ADJACENT DEVELOPMENT
13. IMPROVE THE VISIBLE ASPECTS OF THE AREA
14. IMPROVE OR ENHANCE THE OPEN SPACE OPPORTUNITIES
15. IMPROVE OR ENHANCE THE CLEAN UP OF THE RMA

During the evaluation process, each reach for each alternative was rated separately for the engineering and environmental/aesthetic considerations on the scale of 1 to 5. When evaluating different plans, the ratings for each reach and each plan are compared so that there is consistency between the plans.

The relative importance is similar to a weighing factor and varies from 1 to the number of variables investigated (ie: 8 for the engineering considerations). The relative importance will vary from reach to reach, between Irondale Gulch and First Creek, as well as between the engineering parameters and the environmental parameters.

The next step was to compare the engineering parameters to the environmental parameters for each reach (independent of plan or alternative). The relative crating (percent) identifies for each reach whether the engineering parameters

or the environmental parameters are considered more or less important, on a scale of 0 to 100 percent.

The final step combines the rating for engineering and aesthetic considerations by multiplying the subtotal for each reach by the relative rating and then normalizing the total points based on the maximum total points that can be obtained for each consideration.

D. ALTERNATIVE ASSESSMENT

A summary of the rating for lower Irondale Gulch is presented in Table VI-7 for each of the four plans. Details of the rating are presented in Appendix B. The plans are rated for the condition without regional detention in upper Irondale Gulch, since the detention was not found to have a significant flood reduction benefits for the lower reaches of Irondale Gulch.

For each planning reach, the jurisdiction, the rating for the Engineering factors, the rating for the environmental and aesthetic factors, the relative rating and the grand totals are presented. The grand total ratings for each plan are summarized at the bottom of the table. Based on the these grand totals, Plan 1 is rated the highest, primarily due to the cost, with Plan 2 being only 2 % less.

A summary of the ratings for First Creek are presented in Table VI-6. The ratings include the benefits of the recommended basin wide detention plan, Plan 5, which includes Green's reservoir, the modified detention in Aurora, and Picadilly detention. Details of the rating are presented in Appendix B.

As can be seen from Table VI-6, the best overall alternative is a combination of the Engineered Floodway, the Engineered Wetland and the Open Space Conveyance channel alternative. In addition, the best plan includes simple erosion control structures within the RMA boundary.

FILE NAME: TBL6-1 18-Nov-88

UNADJUSTED STORMS FOR MAIN CHANNEL AND OUTFALL CHANNEL DESIGN

TABLE VI-1A

REACH	DESIGN POINT	AREA (ACRES)	STATION (100 FT)	EQUATION	COMMENTS	FUTURE DEVL/EXIST FACIL/W-AIRP 2-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRP 5-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRP 10-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRP 100-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 1 2-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 1 5-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 1 10-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 1 100-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 2 2-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 2 5-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 2 10-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 2 100-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 3 2-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 3 5-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 3 10-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 3 100-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 4 2-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 4 5-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 4 10-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN 4 100-YEAR (CFS)
I	92	19,943	0	0+00 IR1	S PLA RIV	1448	2356	2921	7145	1415	2273	2809	6627	1415	2273	2809	6627	1415	2273	2809	6627	1415	2273	2809	6627
I	90	19,437	66	0+00 IL1	N OF 88TH	1585	2526	3103	7039	1550	2462	3003	6605	1550	2462	3003	6605	1550	2462	3003	6605	1550	2462	3003	6605
I	86	17,946	84		I-76	1069	1664	2019	4352	1037	1611	1938	3999	1037	1611	1938	3999	1037	1611	1938	3999	1037	1611	1938	3999
I	84	17,543	101	0+00 IL2	E 88TH	871	1312	1577	3327	842	1238	1465	2884	842	1238	1465	2884	842	1238	1465	2884	842	1238	1465	2884
I	83	17,421	122		UPRR	788	1182	1417	2979	762	1117	1320	2560	762	1117	1320	2560	762	1117	1320	2560	762	1117	1320	2560
I	82	16,999	149		E 88TH	420	646	795	2303	374	541	642	1221	374	541	642	1221	374	541	642	1221	374	541	642	1221
I	1	12,134	204		ARSNL BNDR	67	118	321	2109	58	76	130	544	58	76	130	544	29	76	130	544	27	76	130	544
I	209	11,494	284	D/S	R R LAKE	71	254	379	2290	62	66	68	313	62	66	68	294	30	45	52	75	28	40	46	72
I	3	11,097	301		S OF 72ND	422	798	1022	2638	209	241	249	511	209	241	249	511	51	82	100	364	40	65	80	311
I	200	10,656	336	D/S	MARY OUT	431	842	1067	2697	210	241	250	504	210	241	250	504	53	83	101	344	41	66	81	290
I	4	10,656	336		MARY IN	517	865	1075	2710	218	247	264	552	218	247	264	552	84	121	146	427	74	106	126	370
I	201	10,412	351	D/S	LADORA OUT	513	860	1070	2681	218	243	260	521	218	243	260	521	77	111	133	384	64	92	108	322
I	5	10,412	351		LADORA IN	819	1260	1509	3922	290	358	396	1001	290	358	396	1001	179	251	290	861	175	244	281	781
I	6	10,028	371	0+00 IR & IL3	E 64TH	773	1194	1426	3684	235	255	266	562	235	255	266	562	37	56	68	375	11	16	20	226
IL-1	EL. 152	1,222	0	66+00 I		471	761	942	2221	471	761	942	2221	471	761	942	2221	471	761	942	2221	471	761	942	2221
IL-1	89	1,222	72	0+00 IL1-A	HWY 85	688	1071	1306	2747	688	1071	1306	2747	688	1071	1306	2747	688	1071	1306	2747	688	1071	1306	2747
IL-1	88	198	107		UPRR	201	318	406	879	201	318	406	879	201	318	406	879	201	318	406	879	201	318	406	879
IL-1A	EL. 153	493	0	72+00IL-1		105	187	240	611	105	187	240	611	105	187	240	611	105	187	240	611	105	187	240	611
IL-1A	87	493	30		E 80TH	137	233	295	676	137	233	295	676	137	233	295	676	137	233	295	676	137	233	295	676
IL-1A	93	301	85		HWY 2	52	118	164	471	52	118	164	471	52	118	164	471	52	118	164	471	52	118	164	471
IL-2	EL. 149	122	0	35+00 I		142	207	243	464	142	207	243	464	142	207	243	464	142	207	243	464	142	207	243	464
IL-2	85	122	33		UPRR	217	308	363	628	217	308	363	628	217	308	363	628	217	308	363	628	217	308	363	628
IL-3	8	3,277	0		E 64TH	742	1148	1370	3385	204	206	207	250	204	206	207	250	0	6	7	50	4	6	8	58
IL-3	202	3,091	30	D/S	SOUTHGATE	747	1167	1390	3521	200	200	200	235	200	200	200	235	1	1	1	20	1	2	2	27
IL-3	9	3,091	30		SEC 11	1012	1426	1646	3933	1012	1426	1646	3368	1012	1426	1646	3368	2	3	3	70	2	3	3	70
IL-3	12	2,688	40		N OF 56TH	952	1341	1547	3626	952	1341	1547	3091	952	1341	1547	3091	0	0	0	0	0	0	0	0
IL-3	74	2,477	48		HAVANA	859	1210	1404	3234	859	1210	1404	2775	859	1210	1404	2775	970	1372	1592	3174	1894	2777	3319	7074
IL-3E	11	211	0	30+00 IL-3	N OF 56TH	138	204	239	503	138	204	239	503	138	204	239	503	0	204	239	0	0	204	239	0
IL-3E	13	211	28		E 56TH	209	289	332	632	209	289	332	632	209	289	332	632	209	289	332	632	209	289	332	632
IL-3F	10	205	0	30+00 IL-3	SEC 11	76	115	137	326	76	115	137	326	76	115	137	326	0	115	137	0	0	115	137	0
IL-3F	14	205	36		E 56TH	135	191	222	413	135	191	222	413	135	191	222	413	135	191	222	413	135	191	222	413
IL-4	39	608	0	20+00 IR	PEORIA	37	56	66	296	37	56	66	296	37	56	66	296	37	56	66	296	4	5	6	125
IL-4	40	147	55		ARSNL BNDR	75	104	120	288	75	104	120	288	75	104	120	288	75	104	120	288	75	104	120	288
IL-5	7	6,752	0		E 64TH	33	50	61	1735	33	50	61	325	33	50	61	325	33	50	61	325	7	10	13	172
IL-5	37	6,477	20	0+00 IL-4	PEORIA	38	58	68	1812	38	58	68	300	38	58	68	300	38	58	68	300	6	9	10	130
IL-5	203	5,868	33	D/S	LOWR DERBY	21	49	58	1766	4	6	7	57	4	6	7	42	4	6	7	42	4	6	7	14
IL-5	38	5,868	33		LOWR DERBY	308	785	1091	3344	135	188	217	1042	135	188	217	493	135	188	217	493	136	189	218	469
IL-5	204	5,594	64		UPPR DERBY	306	764	1064	3246	0	1	5	1016	0	0	0	476	0	0	0	476	2	3	4	19
IL-5	41	5,594	76		UPPR DERBY	928	1389	1678	3719	928	1389	1678	3719	928	1389	1678	3719	928	1389	1678	3719	288	405	469	847
IL-5	42	5,050	89	0+00 IR-2	E 64TH	867	1300	1564	3504	867	1300	1564	3504	867	1300	1564	3504	867	1300	1564	3504	14	23	29	219
IL-5	44	2,611	89		E 64TH	577	862	1032	2192	577	862	1032	2192	577	862	1032	2192	577	862	1032	2192	12	21	27	169
IL-5	45	2,515	115	0+00 IL-5C	SEC 12	585	887	1059	2240	585	887	1059	2240	585	887	1059	2240	585	887	1059	2240	14	24	30	160
IL-5	47	2,035	115		SEC 12	553	838	999	2045	553	838	999	2045	553	838	999	2045	553	838	999	2045	0	0	0	0
IL-5	51	2,035	149		ARSNL BNDR	562	855	1030	2131	562	855	1030	2131	562	855	1030	2131	562	855	1030	2131	562	855	1030	2131

PEAK FLOWS FOR ALTERNATIVES-LOWER IRONDALE GULCH

FILE NAME: TBL6-1 18-Nov-88

TABLE VI-1B

UNADJUSTED STORMS FOR MAIN CHANNEL AND OUTFALL CHANNEL DESIGN

REACH	DESIGN POINT	AREA (ACRES)	STATION (100 FT)	EQUATION	COMMENTS	FUTURE DEVL/EXIST FACIL/W-AIRP				FUTURE DEVL/W-AIRPORT/PLAN 1				FUTURE DEVL/W-AIRPORT/PLAN 2				FUTURE DEVL/W-AIRPORT/PLAN 3				FUTURE DEVL/W-AIRPORT/PLAN 4			
						2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)	2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)	2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)	2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)	2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)
IL-5B	65	58	0	18+00 IL-5C	POTOMAC	22	32	38	106	22	32	38	106	22	32	38	106	22	32	38	106	0	0	0	0
IL-5B	48	58	18		ARSNL BNDR	35	49	57	129	35	49	57	129	35	49	57	129	35	49	57	129	35	49	57	129
IL-5C	46	480	0		SEC 12	36	58	70	281	36	58	70	281	36	58	70	281	36	58	70	281	14	24	30	160
IL-5C	63	352	18	0+00 IL-5B	POTOMAC	44	69	82	283	44	69	82	283	44	69	82	283	44	69	82	283	19	30	36	151
IL-5C	64	294	18		POTOMAC	28	44	53	201	28	44	53	201	28	44	53	201	28	44	53	201	19	30	36	151
IL-5C	49	205	42		W OF CHAMB	60	86	100	278	60	86	100	278	60	86	100	278	60	86	100	278	56	78	90	225
IL-5C	50	64	65		ARSNL BNDR	37	52	60	137	37	52	60	137	37	52	60	137	37	52	60	137	37	52	60	137
IR-1	EL. 156	250	0	0+00 I		201	333	417	896	201	333	417	896	201	333	417	896	201	333	417	896	201	333	417	896
IR-1	91	250	33		I-76	303	472	589	1171	303	472	589	1171	303	472	589	1171	303	472	589	1171	303	472	589	1171
IR-2	43	2,439	0		POTOMAC	294	440	532	1312	294	440	532	1312	294	440	532	1312	294	440	532	1312	2	2	3	54
IR-2	210	2195	81		PARKFIELD	458	667	780	1975	458	667	780	1975	458	667	780	1975	458	667	780	1975	458	667	780	1975
IR-2	66	2,195	81	0+00 IR-2B	CHAMBERS	458	667	780	1975	458	667	780	1975	458	667	780	1975	458	667	780	1975	458	667	780	1975
IR-2	67	1,478	81		CHAMBERS	328	483	566	1417	328	483	566	1417	328	483	566	1417	328	483	566	1417	328	483	566	1417
IR-2B	68	717	0		CHAMBERS	135	185	214	558	135	185	214	558	135	185	214	558	135	185	214	558	135	185	214	558
DI	82		149	0+00 DI-L1A		69	206	322	1344	69	206	322	1344	69	206	322	1344	69	206	322	1344	69	206	322	1344
DI	81		40		NO OUTFLOW	130	274	377	1237	130	274	377	1237	130	274	377	1237	130	274	377	1237	130	274	377	1237
DI	207	1050	104		RESERV F	267	430	525	1120	267	430	525	1120	267	430	525	1120	267	430	525	1120	267	430	525	1120
DI	208	928	127		U/S RES F	102	192	246	800	102	192	246	800	102	192	246	800	102	192	246	800	102	192	246	800
DI	24	749	151		E BOTH	22	117	183	676	22	117	183	676	22	117	183	676	22	117	183	676	22	117	183	676
DI	25	461	176		PEORIA	19	91	134	425	19	91	134	425	19	91	134	425	19	91	134	425	19	91	134	425
DI	78	1690	22	0+00 DI-L1A	HWY 2	76	207	324	1353	76	207	324	1353	76	207	324	1353	76	207	324	1353	76	207	324	1353
DI-1LB	79	1069	22	0+00 DI-L1B	HWY 2	71	138	209	819	71	138	209	819	71	138	209	819	71	138	209	819	71	138	209	819
DI-L1A	80	621	22	0+00 DI-L1A	HWY 2	15	69	116	536	15	69	116	536	15	69	116	536	15	69	116	536	15	69	116	536
DI-L1C	26	813	34	0+00 DI-L1C	SEC 27	26	89	140	580	26	89	140	580	26	89	140	580	26	89	140	580	26	89	140	580
DI-L1C	27	147	34	0+00 DI-L1C	SEC 27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DI-L1B	28	666	34	0+00 DI-L1B	SEC 27	26	89	140	580	26	89	140	580	26	89	140	580	26	89	140	580	26	89	140	580
DI-L1C	29	0	36		HAVANA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DI-L1B	30	371	86		HAVANA	33	86	123	389	33	86	123	389	33	86	123	389	33	86	123	389	33	86	123	389
DI-L1A	31	371	75		E OF YOSEM	19	65	99	341	19	65	99	341	19	65	99	341	19	65	99	341	19	65	99	341

PEAK FLOWS FOR ALTERNATIVES-LOWER IRONDALE GULCH

PEAK FLOWS - IRONDALE GULCH BASIN
FIRST CREEK, IRONDALE GULCH, DFA 0055 STUDY

PROJECT: ARSENAL PROJ NO 871-090.000 BASIN: IRONDALE GULCH
FILE NAME: TBL6-2 09-Dec-88

UNADJUSTED STORMS FOR MAIN CHANNEL AND OUTFALL CHANNEL DESIGN

REACH	DESIGN POINT	AREA (ACRES)	STATION (100 FT)	EQUATION	COMMENTS	EXISTING DEVL/EXIST FACILITIES 2-YEAR (CFS)	EXISTING DEVL/EXIST FACILITIES 5-YEAR (CFS)	EXISTING DEVL/EXIST FACILITIES 10-YEAR (CFS)	EXISTING DEVL/EXIST FACILITIES 100-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRPT 2-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRPT 5-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRPT 10-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRPT 100-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN A 2-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN A 5-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN A 10-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN A 100-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN B 2-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN B 5-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN B 10-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN B 100-YEAR (CFS)
IL-3	74	2,477	48		HAVANA	820	1152	1332	2932	859	1210	1404	3234	821	1170	1356	2720	750	1082	1240	2607
IL-3	16	2,233	114	D/S	HAVANA	847	1212	1407	3005	912	1314	1525	3096	884	1274	1479	3040	830	1190	1384	2940
IL-3	17	1,619	114		HAVANA	474	684	796	1761	599	861	992	1938	553	801	932	1864	469	673	783	1720
IL-3	25	1,370	180		PEORIA	356	506	588	1404	509	720	830	1647	457	661	762	1568	373	523	607	1420
IL-3	26	1,306	199	0+00 IL-3C	SEC 13	349	503	586	1383	508	718	825	1617	454	658	756	1539	368	523	607	1400
IL-3	27	1,043	199		SEC 13	292	424	495	1106	438	617	709	1311	379	546	629	1204	272	385	447	996
IL-3	29	838	254	0+00 IL-3D	HAVANA	238	341	396	907	412	591	688	1222	349	507	593	1100	250	345	397	874
IL-3	30	557	254		HAVANA	135	193	225	528	263	378	439	753	196	290	339	616	60	87	107	239
IL-3	33	410	294		CHAMBERS	59	83	96	238	249	344	396	610	177	252	295	466	45	66	86	177
IL-3	216	410	294		CHAMBERS 2													45	66	86	177
IL-3	34	262	327		E OF CHAMB	8	11	13	72	294	389	444	537	204	286	331	381	204	286	331	587
IL-3	158		364		DS ROW PND	0	2	2	45	169	233	269	325	15	19	21	36	15	19	21	57
IL-3	213		364		ROW POND									15	19	21	36	15	19	21	58
IL-3	35	90	379		W OF TOWER	0	2	2	45	152	212	245	296	152	212	245	296	152	212	245	418
IL-3A	18	614	0		HAVANA	399	569	660	1321	385	557	649	1274	385	557	649	1274	385	557	649	1274
IL-3A	21	326	29		HAVANA	231	321	372	746	241	336	389	780	241	336	389	780	241	336	389	780
IL-3A	19	614	29	0+00 IL-3B	HAVANA	444	620	718	1428	448	625	724	1452	448	625	724	1452	448	625	724	1452
IL-3A	23	70	91		PEORIA	20	28	33	103	50	68	78	188	50	68	78	188	50	68	78	188
IL-3B	20	288	0		HAVANA	213	299	346	682	207	289	335	672	207	289	335	672	207	289	335	672
IL-3B	24	64	55		PEORIA	30	42	49	119	36	51	59	136	36	51	59	136	36	51	59	136
IL-3C	28	262	0	199+00 IL-3	SEC 13	63	89	103	293	114	161	187	472	114	161	187	472	114	161	187	472
IL-3C	36	134	36		SEC 24	14	20	23	100	74	104	120	284	74	104	120	284	74	104	120	284
IL-3D	31	282	0	254+00 IL-3	SEC 19	108	152	176	379	190	261	301	534	190	261	301	534	190	261	301	635
IL-3D	32	122	60		CHAMBERS	0	2	2	47	179	253	294	353	179	253	294	353	179	253	294	501
IL-3F	14	205	36		E 56TH	158	225	262	477	135	191	222	413	135	191	222	413	135	191	222	413
IL-3F	15	115	55		S OF 56TH	67	95	109	234	46	64	74	180	46	64	74	180	46	64	74	180
IL-5	51	2,035	149		ARSNL BNDR	303	426	493	1202	562	855	1030	2131	320	451	555	1287	309	438	508	1247
IL-5	52	1,978	164	0+00 IL-5A	SEC 13	280	400	464	1119	559	850	1026	2124	305	440	551	1231	296	423	491	1196
IL-5	54	1,683	164		SEC 13	175	252	293	712	522	792	952	1970	285	416	519	1062	188	271	315	743
IL-5	56	1,472	209	D/S	SEC 18	99	139	158	425	526	801	962	1987	276	409	513	1056	144	201	232	534
IL-5	62	1,306	209		SEC 18	56	81	89	265	503	763	914	1883	267	395	493	1016	78	111	127	278
IL-5	57	1,203	251		CHAMBERS	59	84	97	261	522	785	934	1923	266	394	494	1025	55	64	82	183
IL-5	215		251		CHAMBERS 1													59	68	86	177
IL-5	58	1,081	288		E OF CHAMB	61	85	98	254	548	819	968	1956	264	391	491	1035	71	88	128	298
IL-5	212		323		ROW POND									258	381	479	1037	65	70	126	288
IL-5	59	934	323		W OF TOWER	36	56	69	255	561	835	986	1960	288	418	489	1007	288	418	489	1007
IL-5	60	781	368		TOWER RD	44	66	80	293	641	928	1084	2058	306	425	490	894	306	425	490	894
IL-5	61	525	424		SKY AIRPOR	79	110	127	407	691	971	1126	1818	691	971	1126	1958	691	971	1126	1958
IL-5A	53	294	0	164+00 IL-5	SEC 13	105	148	172	421	108	155	181	458	108	155	181	458	108	155	181	458
IL-5A	55	154	42		SEC 18	36	50	58	172	78	109	125	300	78	109	125	300	78	109	125	300

PEAK FLOWS FOR ALTERNATIVES-UPPER IRONDALE GULCH

PEAK FLOWS - IRONDALE GULCH BASIN
FIRST CREEK, IRONDALE GULCH, DFA 0055 STUDY

PROJECT: ARSENAL PROJ NO 871-090.000 BASIN: IRONDALE GULCH
FILE NAME: T8L6-2 15-Dec-88

UNADJUSTED STORMS FOR MAIN CHANNEL AND OUTFALL CHANNEL DESIGN

REACH	DESIGN POINT	AREA (ACRES)	STATION (100 FT)	EQUATION	COMMENTS	EXISTING DEVL/EXIST FACILITIES 2-YEAR (CFS)	EXISTING DEVL/EXIST FACILITIES 5-YEAR (CFS)	EXISTING DEVL/EXIST FACILITIES 10-YEAR (CFS)	EXISTING DEVL/EXIST FACILITIES 100-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRPT 2-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRPT 5-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRPT 10-YEAR (CFS)	FUTURE DEVL/EXIST FACIL/W-AIRPT 100-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN A 2-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN A 5-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN A 10-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN A 100-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN B 2-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN B 5-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN B 10-YEAR (CFS)	FUTURE DEVL/W-AIRPORT/PLAN B 100-YEAR (CFS)
IR-2	67	1,478	81		CHAMBERS	94	140	170	455	328	483	566	1417	294	433	506	1277	294	433	506	1277
IR-2	71	902	153		W OF TOWER	113	161	188	475	319	459	535	1183	277	394	457	1007	277	394	457	1007
IR-2	72	595	207		TOWER RD	171	240	277	566	269	368	422	819	199	269	307	587	199	269	307	587
IR-2	73	448	220	0+00 IR-2A	E OF TOWER	148	207	239	474	158	222	255	494	92	126	144	288	92	126	144	288
IR-2	205	320	233		G V RANCH	50	63	71	129	57	74	82	237	57	74	82	237	57	74	82	237
IR-2	77	320	233		SEC 22	110	153	176	349	141	194	223	420	141	194	223	420	141	194	223	420
IR-2	206	192	269		G V RANCH	13	14	14	16	13	14	15	17	13	14	15	17	13	14	15	17
IR-2A	75	128	0	220+00 IR-2	E OF TOWER	119	168	195	402	122	173	202	409	68	93	108	201	68	93	108	201
IR-2A	76	77	20		E OF TOWER	94	131	152	281	103	143	166	300	103	143	166	300	103	143	166	300
IR-2B	68	717	0		CHAMBERS	226	303	346	779	135	185	214	558	130	169	192	487	130	169	192	490
IR-2B	69	397	65		SEC 17	112	162	189	494	117	168	196	483	81	118	142	345	81	118	142	351
IR-2B	211	160	110		COMB NDC	115	161	185	391	91	127	147	280	54	78	91	186	54	78	91	197
IR-2B	70	160	110		SEC 21	115	161	185	391	91	127	147	280	124	180	211	442	124	180	211	483

PEAK FLOWS FOR ALTERNATIVES-UPPER IRONDALE GULCH

FILE NAME: TBL6-3 18-Nov

ADJUSTED RAINFALL FOR MAIN CHANNEL

TABLE VI-3A

REACH	DESIGN POINT	ACCUM AREA (ACRES)	STATION (100 FT)	EQUATION	COMMENTS	EXIST DEVEL/EXIST FACILITIES 2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)	FUT DEVL/EXIST FACIL/AIRPRT/SLA DET 2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)	COMPARISON OF FLOOD PEAKS PLAN 1 2-YEAR	PLAN 1 100-YEAR	PLAN 2 2-YR	PLAN 2 100-YR	PLAN 3 2-YR	PLAN 3 100-YR	PLAN 4 2-YR	PLAN 4 100-YR	PLAN 5 2-YEAR	PLAN 5 5-YEAR	PLAN 5 10-YEAR	PLAN 5 100-YEAR
FR-6	66	5203	0	811+00 F-1	G V RANCH	5	42	247	2283	532	791	936	2665	532	2665	532	2665	339	2209	532	2665	442	739	867	2421
FR-6	70	4813	38	0+00 FR-6C	G V RANCH	5	41	239	2177	374	556	677	2039	374	2039	374	2039	374	2039	374	2039	339	494	595	1881
FR-6	80	4813	78		PICADILLY	5	41	240	2185	439	628	753	2126	439	2126	439	2126	439	2126	439	2126	418	585	703	1887
F-1	1	30708	0	0+00 FR-1	S PLTE RVR	405	703	1282	7305	1843	2998	3663	10055	589	6147	683	5320	1511	8972	609	5191	589	862	1183	5497
F-1	2	29940	92		BRIGHT RD	458	791	1399	7384	1976	3125	3834	10659	632	6218	709	5418	1612	9364	632	5376	632	967	1225	5568
F-1	3	29652	144	INFLOW DFA	HWY 85	470	798	1408	7399	2029	3169	3898	10925	866	6251	866	5438	1654	9534	866	5497	866	1237	1409	5605
F-1	4	26631	171		I-76	438	703	1252	6950	2024	2951	3642	10253	611	5749	727	4957	1660	8967	971	4527	324	577	1291	5101
F-1	5	26368	219		HWY 2	446	712	1263	6969	2037	2979	3684	10410	625	5768	733	4967	1688	9083	996	4629	327	626	1316	5120
F-1	6	25920	291		E 96TH	460	727	1276	6953	2131	3073	3803	10769	636	5799	739	4977	1752	9315	1005	4794	334	715	1334	5151
F-1	9	25274	344	0+00 FR-2	N OF 88TH	458	715	1255	6842	2173	3122	3856	10895	640	5754	735	4929	1790	9364	999	4740	333	796	1333	5112
F-1	7	23674	344		N OF 88TH	456	693	1192	6501	2172	3102	3787	10295	639	5598	307	1987	1789	8858	1007	4206	328	791	1328	4997
F-1	14	22957	406	0+00 FR-3	N OF BOTH	451	681	1181	6408	2235	3191	3886	10607	649	5603	316	1899	1853	9049	974	4217	332	897	1336	5012
F-1	16	21242	406		N OF BOTH	433	639	1080	5955	2155	3041	3660	9626	630	5388	248	1538	1790	8230	921	4091	307	858	1297	4835
F-1	26	20986	431	0+00 FL-2	E OF POTOM	428	636	1073	5932	2164	3050	3667	9631	631	5381	223	1393	1800	8224	898	4088	310	896	1299	4834
F-1	28	20161	431		E OF POTOM	371	560	995	5834	2112	2966	3556	9215	629	5321	58	276	1763	7939	826	4042	309	876	1290	4783
F-1	84	20076	463		DIV. POINT	378	578	1014	5841	2141	3017	3618	9461	633	5341	2094	8171	1796	8141	824	4040	312	925	1295	4807
F-1	30	20013	487		CHAMBERS	384	592	1029	5846	2162	3055	3665	9645	636	5356	2104	8231	1821	8292	822	4038	315	962	1298	4825
F-1	34	19348	533	0+00 FR-4	N OF 64TH	408	640	1057	5778	2214	3141	3750	9930	645	5326	2156	8407	1880	8580	820	3996	321	1021	1303	4815
F-1	36	19021	533		N OF 64TH	408	638	1044	5755	2202	3121	3720	9718	644	5311	2145	8238	1870	8435	819	3985	320	1018	1300	4804
F-1	200	19021	562		GREEN'S RES									647	5324							323	1040	1303	4821
F-1	38	19021	562	0+00 FR-5	S OF 64TH	429	673	1070	5767	2229	3161	3766	9900	2229	9900	2171	8389	1895	8669	600	4081	1516	2337	2865	8753
F-1	40	17248	562		S OF 64TH	163	261	732	5355	2025	2814	3307	8045	2025	8045	2025	8045	1879	7529	594	4243	1160	1775	2142	6346
F-1	46	17185	645	ERR 66+10	ARSNL BNDR	164	263	733	5354	2026	2820	3309	8023	2026	8023	2026	8023	1880	7509	595	4249	1162	1783	2144	6322
F-1	48	16730	695		E 56TH	172	269	730	5333	2021	2799	3271	7919	2021	7919	2021	7919	1873	7515	1924	4791	1166	1766	2106	6193
F-1	49	16602	716	0+00 FL-4	TOWER RD	174	269	730	5329	2016	2789	3253	7883	2016	7883	2016	7883	1869	7480	2016	7883	1156	1746	2074	6061
F-1	51	16257	760		SEC 15	177	269	727	5289	2007	2761	3206	7685	2007	7685	2007	7685	1858	7375	2007	7685	1146	1717	2014	5738
F-1	52	16116	793	0+00 FL-5	SEC 15	178	270	728	5292	2001	2744	3179	7655	2001	7655	2001	7655	1850	7368	2001	7655	1132	1688	1973	5616
F-1	53	15649	793		SEC 15	66	160	689	5210	1934	2641	3053	7186	1934	7186	1934	7186	1793	6994	1934	7186	966	1427	1667	5187
F-1	61	15540	803	0+00 FR-6A	SEC 15	66	160	689	5193	1922	2620	3025	7111	1922	7111	1922	7111	1781	7087	1922	7111	937	1382	1608	5165
F-1	63	15303	803		SEC 15	46	150	679	5169	1895	2579	2970	6993	1895	6993	1895	6993	1781	6879	1895	6993	880	1296	1531	5119
F-1	64	15303	811	0+00 FR-6B	SEC 14	46	150	679	5170	1898	2579	2972	6986	1898	6986	1898	6986	1783	6958	1898	6986	886	1307	1531	5119
F-1	83	9882	811		SEC 14	44	108	454	3283	1451	1886	2129	4565	1451	4565	1451	4565	1451	4565	1451	4565	386	766	939	3197
F-1	74	9658	860		SEC 23	44	104	449	3269	1450	1875	2103	4485	1450	4485	1450	4485	1450	4485	1450	4485	387	761	936	3237
F-1	75	9536	883		HIGH CANAL	39	102	448	3269	1436	1856	2084	4483	1436	4483	1436	4483	1436	4483	1436	4483	387	755	931	3238
F-1	76	9274	941	0+00 FL-6	PICADILLY	43	100	446	3256	1442	1832	2058	4432	1442	4432	1442	4432	1442	4432	1442	4432	388	791	949	3453
F-1	77	9018	941		PICADILLY	7	91	435	3209	1375	1730	1932	4048	1375	4048	1375	4048	1375	4048	1375	4048	386	754	907	3224

NOTES:

Plan 1- Greens Reservoir, Airport Boulevard, Airport Boulevard North.

Plan 2- Henderson Hill and Airport Boulevard North.

Plan 3- Developers Alternative Sites 1&2, Airport Boulevard North.

Plan 4- SLA Outlet Modifications and Picadilly Detention.

Plan 5- WWE Plan: Greens Reservoir, Airport Boulevard North, SLA Modifications, and Picadilly Detention.

PEAK FLOWS FOR ALTERNATIVES-FIRST CREEK

TABLE VI-3B

REACH	DESIGN POINT	ACCUM AREA (ACRES)	STATION (100 FT)	EQUATION	COMMENTS	EXIST DEVEL/EXIST FACILITIES 2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)	FUT DEVL/EXIST FACIL/AIRPRT/SLA DET 2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)	COMPARISON OF FLOOD PEAKS PLAN 1 2-YEAR	PLAN 1 100-YEAR	PLAN 2 2-YR	PLAN 2 100-YR	PLAN 3 2-YR	PLAN 3 100-YR	PLAN 4 2-YR	PLAN 4 100-YR	PLAN 5 2-YEAR	PLAN 5 5-YEAR	PLAN 5 10-YEAR	PLAN 5 100-YEAR
FL-2	27	826	0	430+90 F-1	E OF POTOM	265	462	586	1470	232	404	515	1336	232	1336	232	1336	232	1336	232	1336	232	404	515	1336
FL-2	29	531	45		E 72ND	412	664	820	1731	412	664	820	1740	412	1740	412	1740	412	1740	412	1740	412	664	820	1740
FL-3	46 U/S	268	0	645+00 F-1	BUCKLEY																				
FL-3	47	166	30		E 56TH	3	40	67	248	176	273	347	734	176	734	176	734	176	734	176	734	176	273	347	734
FL-4	50 D/S	96	0	716+20 F-1	TOWER	7	22	33	105	102	155	186	367	102	367	102	367	102	367	102	367	102	155	186	367
FL-4	50	96	15		TOWER	7	22	33	105	102	155	186	367	102	367	102	367	102	367	102	367	102	155	186	367
FL-5	54	467	0	793+00 F-1	SEC 15	138	244	313	832	312	513	636	1433	312	1433	312	1433	312	1433	312	1433	312	513	636	1433
FL-5	55	378	20		SEC 22	142	244	309	763	286	460	560	1217	286	1217	286	1217	286	1217	286	1217	286	460	560	1217
FL-5	57	307	30		SEC 22	106	188	238	606	237	380	464	1006	237	1006	237	1006	237	1006	237	1006	237	380	464	1006
FL-5	56	332	30		SEC 22	129	223	281	677	256	408	497	1079	256	1079	256	1079	256	1079	256	1079	256	408	497	1079
FL-5	60	186	53		SEC 23	125	210	263	600	200	311	379	767	200	767	200	767	200	767	200	767	200	311	379	767
FL-5	82	122	69		SEC 23	120	197	249	539	167	252	305	595	167	595	167	595	167	595	167	595	167	252	305	595
FL-5A	58	26	0	30+00 FL-5	SEC 22	24	40	49	105	37	56	68	133	37	133	37	133	37	133	37	133	37	56	68	133
FL-5A	59	26	10		SEC 22	36	54	65	127	36	54	65	127	36	127	36	127	36	127	36	127	36	54	65	127
FL-6	78	256	0	941+25 F-1	PICADILLY	54	107	137	336	210	325	388	770	210	770	210	770	210	770	210	770	210	325	388	770
FL-6	79	96	60		SEC 35	4	29	42	128	159	232	276	483	159	483	159	483	159	483	159	483	159	232	276	483
FR-1	EL. 149	173	0			6	23	37	171	83	131	158	355	316	910	316	910	316	910	316	910	316	131	158	910
FR-1	81	173	40		BRIGHT RD	15	57	83	262	316	447	528	910	316	910	316	910	316	910	316	910	316	447	528	910
FR-2	204		0		DETENTION											737	4796								
FR-2	10	1,600	0	0+00 F-1	N OF 88TH	7	131	236	1060	7	124	219	989	7	989	2106	9079	7	989	7	989	7	124	219	989
DIV	86		0		EDGE DET											2105	8470								
DIV	85		52		E 80TH											2119	8524								
DIV	88		52		FROM DP84											2075	7904								
DIV	87		52	0+00	TRIB FR-3											51	862								
FR-2	11	845	68		CHAMBERS	8	100	167	670	8	98	163	655	8	655	8	655	8	655	8	655	8	98	163	655
FR-2	12	653	80		E OF CHAMB	9	80	127	495	9	79	124	477	9	477	9	477	9	477	9	477	9	79	124	477
FR-2	13	269	119		E 88TH	3	41	65	227	3	41	65	227	3	227	3	227	3	227	3	227	3	41	65	227
FR-3	15	1,715	0	405+90 F-1	E OF POTOM	122	214	274	874	122	244	365	1191	122	980	121	592	122	1138	121	592	122	244	365	980
FR-3	17	1,478	47	0+00 FR-3B	CHAMBERS	12	110	194	848	108	268	389	1298	71	1074	71	1074	94	1238	71	1074	71	268	389	1074
FR-3	18	813	47		CHAMBERS	3	70	126	556	63	176	257	865	63	865	63	865	63	865	63	865	63	176	257	865
FR-3	20	640	63		E 80TH	4	61	107	445	68	173	245	761	68	761	68	761	68	761	68	761	68	173	245	761
FR-3	21	550	85	0+00 FR-3A	S OF 80TH	7	64	102	407	85	198	266	755	85	755	85	755	85	755	85	755	85	198	266	755
FR-3	22	192	85		S OF 80TH	2	21	38	153	58	114	147	377	58	377	58	377	58	377	58	377	58	114	147	377
FR-3	24	154	103		BUCKLEY	0	22	36	126	95	162	200	426	95	426	95	426	95	426	95	426	95	162	200	426
FR-3A	23	358	0	85+00 FR-3	S OF 80TH	6	47	71	254	31	85	122	394	31	394	31	394	31	394	31	394	31	85	122	394
FR-3A	25	134	45		BUCKLEY	0	17	28	108	84	140	173	374	84	374	84	374	84	374	84	374	84	140	173	374
FR-3B	19	666	0	47+00 FR-3	CHAMBERS	10	45	70	314	51	106	148	469	14	215	14	215	35	405	14	215	14	45	66	215
FR-3B	31	422	70		E 72ND	12	37	58	245	81	147	191	551	17	73	17	73	58	450	17	73	17	25	29	73
FR-3B	202	352	88		AIRPRT BVD									19	65	19	65					19	25	29	65
FR-3B	32	352	88		BUCKLEY	20	60	89	315	202	330	410	907	202	907	202	907	167	711	202	907	202	330	410	907
FR-3B	33	96	141		TOWER	112	168	209	415	112	168	209	418	112	418	112	418	112	418	112	418	112	168	209	418

PEAK FLOWS FOR ALTERNATIVES-FIRST CREEK

TABLE VI-3C

REACH	DESIGN POINT	ACCUM AREA (ACRES)	STATION (100 FT)	EQUATION	COMMENTS	EXIST DEVEL/EXIST FACILITIES 2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)	FUT DEVL/EXIST FACIL/AIRPRT/SLA DET 2-YEAR (CFS)	5-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)	COMPARISON OF FLOOD PEAKS PLAN 1 2-YEAR	PLAN 1 100-YEAR	PLAN 2 2-YR	PLAN 2 100-YR	PLAN 3 2-YR	PLAN 3 100-YR	PLAN 4 2-YR	PLAN 4 100-YR	PLAN 5 2-YEAR	PLAN 5 5-YEAR	PLAN 5 10-YEAR	PLAN 5 100-YEAR
FR-4	35	326	0	532+90 F-1	N OF 64TH	3	45	78	356	33	97	142	470	33	470	33	470	33	470	33	470	33	97	142	470
FR-4	37	109	30		BUCKLEY	2	27	44	166	109	173	219	471	109	471	109	471	109	471	109	471	109	173	219	471
FR-5	39	1,773	0	561+90 F-1	W OF BUCKL	328	600	783	2226	578	997	1262	3258	578	3258	172	800	161	1736	172	800	578	997	1262	3258
FR-5	201	1,504	33		AIRPRT BVD	370	652	832	2208	674	1122	1401	3299	633	3299	141	338	0	3299	141	338				
FR-5	41	1,504	33		SEC 9	370	652	832	2208	674	1122	1401	3299	674	3299	674	3299	674	3299	674	3299	674	1122	1401	3299
FR-5	42	1,280	65		TOWER	521	860	1063	2460	633	1041	1291	2911	633	2911	633	2911	633	2911	633	2911	633	1041	1291	2911
FR-5	43	877	87		SEC 10	395	648	794	1735	358	592	741	1717	358	1717	358	1717	358	1717	358	1717	358	592	741	1717
FR-5	44	538	122		HIGH CANAL	287	451	550	1096	82	186	255	763	82	763	82	763	82	763	82	763	82	186	255	763
FR-5	45	218	172		PICADILLY	3	42	70	256	129	232	297	682	129	682	129	682	129	682	129	682	129	232	297	682
FR-6A	62	234	0		SEC 15	78	157	206	529	267	369	439	906	267	906	267	906	267	906	267	906	267	369	439	906
FR-6A	67	134	33		SEC 14	165	250	310	619	167	252	311	622	167	622	167	622	167	622	167	622	167	252	311	622
FR-6B	65	218	0		SEC 14	0	22	39	199	265	362	421	785	265	785	265	785	265	785	265	785	265	362	421	785
FR-6B	71	83	42		PICADILLY	0	19	31	116	151	211	246	418	151	418	151	418	151	418	151	418	151	211	246	418
FR-6C	68	5203	0	37+50 FR-6	SEC 14	7	257	548	2742	646	955	1113	2803	646	2803	646	2803	374	2847	646	2803	646	929	1069	2803
FR-6C	69	390	0		SEC 14	2	49	91	441	424	638	756	1513	424	1513	424	1513	424	1513	424	1513	424	638	756	1513
FR-6C	72	326	17		PICADILLY	2	45	83	375	441	646	758	1408	441	1408	441	1408	441	1408	441	1408	441	646	758	1408
FR-6C	73	147	42		SEC 13	2	32	53	186	280	394	462	777	280	777	280	777	280	777	280	777	280	394	462	777
DF	1		0	0+00 DF-L1	UPRR	74	270	445	1810	734	1125	1355	2963	734	2963	734	2963	734	2963	734	2963	734	1125	1355	2963
DF-L1	2	410	0		UPRR	34	75	104	344	300	436	512	955	300	955	300	955	300	955	300	955	300	436	512	955
DF	3	285	0		UPRR	41	209	359	1531	438	705	868	2092	438	2092	438	2092	438	2092	438	2092	438	705	868	2092
DF-L1	4	166	40		E. 96TH	91	157	197	449	239	340	398	706	239	706	239	706	239	706	239	706	239	340	398	706
DF-L2	5	301	41		S OF 96TH	43	116	158	453	246	394	475	961	246	961	246	961	246	961	246	961	246	394	475	961
DF-L2	6	90	71		BUR DITCH	33	71	94	244	89	144	182	386	89	386	89	386	89	386	89	386	89	144	182	386
DF-L2	7	493	0		S OF I-76	41	107	151	508	306	454	539	1028	306	1028	306	1028	306	1028	306	1028	306	454	539	1028
DF	15	1792	0	0+00 DF	I-76	15	145	259	1193	246	412	514	1351	246	1351	246	1351	246	1351	246	1351	246	412	514	1351
DF	16	1792	20		I-76	16	154	273	1240	360	555	672	1454	360	1454	360	1454	360	1454	360	1454	360	555	672	1454
DF-L3	17	224	0		I-76	2	20	35	169	126	198	240	510	126	510	126	510	126	510	126	510	126	198	240	510
DF	18	1568	20		I-76	15	138	245	1094	238	366	441	1060	238	1060	238	1060	238	1060	238	1060	238	366	441	1060
DF-L3	8	122	40		E 96TH	4	33	51	177	158	237	292	573	158	573	158	573	158	573	158	573	158	237	292	573
DF-L4	9	186	33		BUR DITCH	0	21	38	187	129	187	224	418	129	418	129	418	129	418	129	418	129	187	224	418
DF-L4	10	90	53		HWY 2	0	20	32	112	0	20	32	112	0	112	0	112	0	112	0	112	0	20	32	112
DF	19	1382	20	0+00 DF-L4	S OF I-76	15	127	223	965	221	335	401	897	221	897	221	897	221	897	221	897	221	335	401	897
DF	20	1229	53		BUR DITCH	20	142	241	980	156	249	301	905	156	905	156	905	156	905	156	905	156	249	301	905
DF	12	1139	73	0+00 DF-L5	HWY 2	29	150	246	964	178	257	305	906	178	906	178	906	178	906	178	906	178	257	305	906
DF	21	922	73		HWY 2	29	114	187	730	178	256	303	672	178	672	178	672	178	672	178	672	178	256	303	672
DF-L5	22	218	73	0+00 DF-L5	HWY 2	2	37	63	247	2	37	63	247	2	247	2	247	2	247	2	247	2	37	63	247
DF-L5	11	218	14		E 96TH	4	53	82	269	4	53	82	269	4	269	4	269	4	269	4	269	4	53	82	269
DF	13	819	95		E 96TH	15	116	181	690	15	114	177	664	15	664	15	664	15	664	15	664	15	114	177	664
DF	14	314	153		E 88TH	15	67	103	352	15	67	103	353	15	353	15	353	15	353	15	353	15	67	103	353

PEAK FLOWS FOR ALTERNATIVES-FIRST CREEK

FILE:FIRSTCSD.WK1 PROJECT: 871-090.010 DATE: 29-Aug-88

AREA	PLANNING REACH	COST FOR ENGINEERED FLOODWAY: DRAINAGE IMPROVMNTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL	COST FOR ENGINEERED GRASS/WETLAND CHANNEL: DRAINAGE IMPROVMNTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL	COST FOR NATURAL OPEN SPACE CHANNEL: DRAINAGE IMPROVMNTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY ENGNRG, ADMN (NOTE 1)	SUBTOTAL
HAZELTINE	PRF-1	$4,507,293	$173,677	$0	$34,735	$763,001	$1,872,388	$7,351,095	$5,441,324	$173,677	$0	$34,735	$1,371,089	$2,246,001	$9,266,827	$4,716,329	$173,677	$0	$34,735	$6,745,523	$1,956,003	$13,626,268
	PRF-2	$3,250,205	$278,083	$0	$55,617	$1,580,843	$1,411,315	$6,576,062	$3,088,354	$278,083	$0	$55,617	$1,840,235	$1,346,575	$6,608,863	$2,636,419	$219,462	$0	$43,892	$3,477,732	$1,142,352	$7,519,857
	PRF-3	$2,620,112	$82,596	$0	$16,519	$1,389,804	$1,081,083	$5,190,114	$2,516,461	$82,596	$0	$16,519	$1,614,977	$1,039,623	$5,270,176	$2,065,172	$82,596	$0	$16,519	$3,061,777	$859,107	$6,085,170
ARSENAL	PRF-4	$195,001	$0	$0	$0	$0	$78,000	$273,001	$195,001	$0	$0	$0	$0	$78,000	$273,001	$195,001	$0	$0	$0	$0	$78,000	$273,001
	PRF-5	$416,465	$137,928	$5,111,170	$27,586	$1,980,000	$2,266,225	$9,939,374	$416,465	$137,928	$5,111,170	$27,586	$1,980,000	$2,266,225	$9,939,374	$416,465	$137,928	$5,111,170	$27,586	$1,980,000	$2,266,225	$9,939,374
FRST CR RNCH	PRF-6	$5,380,306	$373,707	$0	$74,741	$2,718,481	$2,301,605	$10,848,841	$5,821,629	$373,707	$0	$74,741	$3,041,453	$2,478,134	$11,789,664	$4,394,753	$373,707	$0	$74,741	$6,165,358	$1,907,384	$12,915,943
	PRF-7	$5,334,244	$45,195	$0	$9,039	$2,408,463	$2,151,775	$9,948,716	$5,348,529	$45,195	$0	$9,039	$2,950,680	$2,157,489	$10,510,932	$3,290,693	$45,195	$0	$9,039	$5,077,571	$1,334,355	$9,756,853
AURORA	PRF-8	$0	$0	$587,700	$0	$884,000	$235,080	$1,706,780	$0	$0	$587,700	$0	$884,000	$235,080	$1,706,780	$0	$0	$587,700	$0	$884,000	$235,080	$1,706,780
GRN VLY RNCH	PRF-9	$1,903,735	$118,512	$0	$23,702	$692,205	$808,899	$3,547,053	$1,864,669	$118,512	$0	$23,702	$954,419	$793,272	$3,754,575	$737,503	$118,512	$0	$23,702	$1,299,518	$342,406	$2,521,641
AURORA	PRF-10	$0	$0	$55,000	$0	$0	$22,000	$77,000	$0	$0	$55,000	$0	$0	$22,000	$77,000	$0	$0	$55,000	$0	$0	$22,000	$77,000
WWE TOTAL		$23,607,361	$1,209,697	$5,753,870	$241,939 (NOTE 3)	$12,416,797	$12,228,371	$55,458,036	$24,692,433	$1,209,697	$5,753,870	$241,939	$14,636,852	$12,662,400	$59,197,191	$18,452,334	$1,151,076	$5,753,870	$230,215	$28,691,479	$10,142,912	$64,421,887
SLA MASTER PLAN (2/)	PRF-8,10	$20,485,075	$0	$8,561,000	$3,870,060	$4,695,000	$11,283,341	$48,894,476	$20,485,075	$0	$8,561,000	$3,870,060	$4,695,000	$11,283,341	$48,894,476	$20,485,075	$0	$8,561,000	$3,870,060	$4,695,000	$11,283,341	$48,894,476
GRAND TOTAL		$44,092,436	$1,209,697	$14,314,870	$4,111,999	$17,111,797	$23,511,712	$104,352,512	$45,177,508	$1,209,697	$14,314,870	$4,111,999	$19,331,852	$23,945,741	$108,091,667	$38,937,409	$1,151,076	$14,314,870	$4,100,275	$33,386,479	$21,426,253	$113,316,363

NOTES: 1/ 40% OF DRAINAGE IMPROVEMENTS, STREET CROSSINGS, AND DETENTION STORAGE.
2/ "SLA MASTER PLAN" IS THE "CITY OF AURORA DRAINAGE MASTER PLAN, FIRST CREEK BASIN COST SUMMARY," p. 11, TABLE 2.
3/ UTILITY RELOCATION IS NOT ITEMIZED SEPARATELY BY THE SLA MASTER PLAN. THE FIGURE SHOWN HERE IS CALLED "OTHER" BY THE SLA REPORT.

TOTAL COST SUMMARY
FIRST CREEK-WWE RECOMMENDED ALTERNATIVE

FILE:FRSTCTRB.WK1 PROJECT: 871-090.010 DATE: 30-Aug-88

AREA	PLANNING REACH	CHANNEL COST--NO DETENTION: DRAINAGE IMPROVMNTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL	CHANNEL COST--WWE RECOMMENDED DETENTION: DRAINAGE IMPROVMNTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL
HAZELTINE	PRF-11	$8,771,718	$151,868	$0	$30,374	$659,865	$3,569,434	$13,183,258	$8,771,718	$151,868	$0	$30,374	$659,865	$3,569,434	$13,183,258
ARSENAL	PRF-12	$885,939	$13,982	$0	$2,796	$570,139	$359,968	$1,832,824	$341,075	$13,982	$232,200	$2,796	$277,604	$234,903	$1,102,559
GVR/	PRF-13	$4,425,315	$171,858	$0	$34,372	$1,839,821	$1,838,869	$8,310,235	$4,425,315	$171,858	$0	$34,372	$1,839,821	$1,838,869	$8,310,235
FRST CR	PRF-14	$1,132,832	$0	$0	$0	$554,025	$453,133	$2,139,990	$1,132,832	$0	$0	$0	$554,025	$453,133	$2,139,990
RANCH	PRF-15	$1,854,405	$53,413	$0	$10,683	$958,146	$763,127	$3,639,774	$1,854,405	$53,413	$0	$10,683	$958,146	$763,127	$3,639,774
		$17,070,208	$391,120	$0	$78,224	$4,581,997	$6,984,532	$29,106,081	$16,525,344	$391,120	$232,200	$78,224	$4,289,461	$6,859,466	$28,375,816

NOTES: 1/ 40% OF DRAINAGE IMPROVEMENTS, STREET CROSSINGS, AND DETENTION STORAGE.

ALTERNATIVE PLAN COST SUMMARY-FIRST CREEK

FILE: IRNCSTWD.WK1

TABLE VI-5A

PLAN 1

MAXIMUM UTILIZATION OF EXISTING FACILITIES

AREA	PLANNING REACH	DRAINAGE IMPROVMTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY, ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL (NOTE 2)
COMMERCE CTY	PR-1	$9,840,483	$1,266,951	$0	$1,968,097	$3,195,000	$4,442,974	$20,713,505
ARSENAL	PR-2	$1,822,747	$70,875	$27,000	$378,724	$469,800	$768,249	$3,537,395
	PR-3	$302,893	$0	$1,804,286	$60,579	$73,800	$842,872	$3,084,429
	PR-4	$0	$0	$0	$0	$0	$0	$0
	PR-5	$708,245	$117,340	$1,028,571	$165,117	$1,593,000	$741,662	$4,353,935
	PR-6	$3,051,543	$112,707	$0	$632,850	$876,400	$1,265,700	$5,939,201
56TH AVE	PR-5,6	$0	$0	$0	$0	$0	$0	$0
MONTBELLO	PR-7	$14,296,947	$0	$325,836	$2,859,389	$0	$5,849,113	$23,331,285
		$30,022,859	$1,567,873	$3,185,692	$6,064,756	$6,208,000	$13,910,570	$60,959,750

PLAN 2

RESERVOIR IMPROVEMENTS AND INCREASED DETENTION

AREA	PLANNING REACH	DRAINAGE IMPROVMTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY, ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL (NOTE 2)
COMMERCE CTY	PR-1	$9,840,483	$1,266,951	$0	$1,968,097	$3,195,000	$4,442,974	$20,713,505
ARSENAL	PR-2	$1,797,836	$68,472	$27,000	$373,262	$469,800	$757,323	$3,493,694
	PR-3	$302,893	$0	$2,005,714	$60,579	$73,800	$923,443	$3,366,429
	PR-4	$0	$0	$0	$0	$0	$0	$0
	PR-5	$708,245	$117,340	$1,028,571	$165,117	$1,593,000	$741,662	$4,353,935
	PR-6	$3,051,543	$112,707	$0	$632,850	$876,400	$1,265,700	$5,939,201
56TH AVE	PR-5,6	$0	$0	$0	$0	$0	$0	$0
MONTBELLO	PR-7	$14,296,947	$0	$325,836	$2,859,389	$0	$5,849,113	$23,331,285
		$29,997,948	$1,565,471	$3,387,121	$6,059,294	$6,208,000	$13,980,216	$61,198,050

PLAN 3

PARTIAL DIVERSION FROM ARSENAL AREA

AREA	PLANNING REACH	DRAINAGE IMPROVMTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY, ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL (NOTE 2)
COMMERCE CTY	PR-1	$9,840,483	$1,266,951	$0	$1,968,097	$3,195,000	$4,442,974	$20,713,505
ARSENAL	PR-2	$1,255,506	$29,671	$27,000	$257,035	$163,800	$524,871	$2,257,883
	PR-3	$302,893	$0	$1,804,286	$60,579	$73,800	$842,872	$3,084,429
	PR-4	$0	$0	$0	$0	$0	$0	$0
	PR-5	$0	$0	$300,000	$0	$0	$120,000	$420,000
	PR-6	$3,051,543	$112,707	$0	$632,850	$876,400	$1,265,700	$5,939,201
56TH AVE	PR-5,6	$4,109,441	$558,490	$285,714	$933,586	$1,591,000	$1,981,458	$9,459,689
MONTBELLO	PR-7	$14,296,947	$0	$325,836	$2,859,389	$0	$5,849,113	$23,331,285
		$32,856,813	$1,967,820	$2,742,836	$6,711,536	$5,900,000	$15,026,988	$65,205,993

PLAN 4

TOTAL DIVERSION FROM ARSENAL AREA

AREA	PLANNING REACH	DRAINAGE IMPROVMTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY, ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL (NOTE 2)
COMMERCE CTY	PR-1	$9,840,483	$1,266,951	$0	$1,968,097	$3,195,000	$4,442,974	$20,713,505
ARSENAL	PR-2	$1,201,997	$26,131	$27,000	$245,626	$160,200	$502,051	$2,163,006
	PR-3	$221,495	$0	$1,661,429	$44,299	$66,600	$753,170	$2,746,993
	PR-4	$0	$0	$0	$0	$0	$0	$0
	PR-5	$0	$0	$300,000	$0	$0	$120,000	$420,000
	PR-6	$666,268	$12,249	$0	$135,703	$200,400	$271,407	$1,286,027
56TH AVE	PR-5,6	$8,309,879	$896,748	$500,000	$1,841,325	$2,945,000	$3,882,651	$18,375,603
MONTBELLO	PR-7	$14,296,947	$0	$325,836	$2,859,389	$0	$5,849,113	$23,331,285
		$34,537,070	$2,202,080	$2,814,264	$7,094,440	$6,567,200	$15,821,366	$69,036,419

NOTES: 1./ CONTINGENCIES, ENGINEERING, AND ADMINISTRATION FOR MASTER PLANNING ARE 40% OF DRAINAGE IMPROVEMENTS, STREET CROSSINGS, AND DETENTION STORAGE.

2./ COMMERCE CITY COSTS ARE FOR 100-YEAR CHANNELIZATION OF THE MAIN BRANCH ONLY.

ALTERNATIVE PLAN COST SUMMARY-IRONDALE GULCH

FILE: IRNCSTWD.WK1

TABLE VI-5B

PLAN 1

MAXIMUM UTILIZATION OF EXISTING FACILITIES

AREA	PLANNING REACH	DRAINAGE IMPROVMTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY, ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL (NOTE 2)
COMMERCE CTY	PR-1	$9,840,483	$1,266,951	$0	$1,968,097	$3,195,000	$4,442,974	$20,713,505
ARSENAL	PR-2	$1,822,747	$70,875	$27,000	$378,724	$469,800	$768,249	$3,537,395
	PR-3	$302,893	$0	$1,804,286	$60,579	$73,800	$842,872	$3,084,429
	PR-4	$0	$0	$0	$0	$0	$0	$0
	PR-5	$708,245	$117,340	$1,028,571	$165,117	$1,593,000	$741,662	$4,353,935
	PR-6	$3,051,543	$112,707	$0	$632,850	$876,400	$1,265,700	$5,939,201
56TH AVE	PR-5,6	$0	$0	$0	$0	$0	$0	$0
MONTBELLO	PR-7	$11,890,797	$0	$657,836	$2,378,159	$3,751,800	$5,019,453	$23,698,045
		$27,616,709	$1,567,873	$3,517,692	$5,583,526	$9,959,800	$13,080,910	$61,326,510

PLAN 2

RESERVOIR IMPROVEMENTS AND INCREASED DETENTION

AREA	PLANNING REACH	DRAINAGE IMPROVMTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY, ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL (NOTE 2)
COMMERCE CTY	PR-1	$9,840,483	$1,266,951	$0	$1,968,097	$3,195,000	$4,442,974	$20,713,505
ARSENAL	PR-2	$1,797,836	$68,472	$27,000	$373,262	$469,800	$757,323	$3,493,694
	PR-3	$302,893	$0	$2,005,714	$60,579	$73,800	$923,443	$3,366,429
	PR-4	$0	$0	$0	$0	$0	$0	$0
	PR-5	$708,245	$117,340	$1,028,571	$165,117	$1,593,000	$741,662	$4,353,935
	PR-6	$3,051,543	$112,707	$0	$632,850	$876,400	$1,265,700	$5,939,201
56TH AVE	PR-5,6	$0	$0	$0	$0	$0	$0	$0
MONTBELLO	PR-7	$11,890,797	$0	$657,836	$2,378,159	$3,751,800	$5,019,453	$23,698,045
		$27,591,798	$1,565,471	$3,719,121	$5,578,064	$9,959,800	$13,150,556	$61,564,810

PLAN 3

PARTIAL DIVERSION FROM ARSENAL AREA

AREA	PLANNING REACH	DRAINAGE IMPROVMTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY, ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL (NOTE 2)
COMMERCE CTY	PR-1	$9,840,483	$1,266,951	$0	$1,968,097	$3,195,000	$4,442,974	$20,713,505
ARSENAL	PR-2	$1,255,506	$29,671	$27,000	$257,035	$163,800	$524,871	$2,257,883
	PR-3	$302,893	$0	$1,804,286	$60,579	$73,800	$842,872	$3,084,429
	PR-4	$0	$0	$0	$0	$0	$0	$0
	PR-5	$0	$0	$300,000	$0	$0	$120,000	$420,000
	PR-6	$3,051,543	$112,707	$0	$632,850	$876,400	$1,265,700	$5,939,201
56TH AVE	PR-5,6	$4,109,441	$558,490	$285,714	$933,586	$1,591,000	$1,981,458	$9,459,689
MONTBELLO	PR-7	$11,890,797	$0	$657,836	$2,378,159	$3,751,800	$5,019,453	$23,698,045
		$30,450,663	$1,967,820	$3,074,836	$6,230,306	$9,651,800	$14,197,328	$65,572,753

PLAN 4

TOTAL DIVERSION FROM ARSENAL AREA

AREA	PLANNING REACH	DRAINAGE IMPROVMTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY, ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL (NOTE 2)
COMMERCE CTY	PR-1	$9,840,483	$1,266,951	$0	$1,968,097	$3,195,000	$4,442,974	$20,713,505
ARSENAL	PR-2	$1,201,997	$26,131	$27,000	$245,626	$160,200	$502,051	$2,163,006
	PR-3	$221,495	$0	$1,661,429	$44,299	$66,600	$753,170	$2,746,993
	PR-4	$0	$0	$0	$0	$0	$0	$0
	PR-5	$0	$0	$300,000	$0	$0	$120,000	$420,000
	PR-6	$666,268	$12,249	$0	$135,703	$200,400	$271,407	$1,286,027
56TH AVE	PR-5,6	$8,309,879	$896,748	$500,000	$1,841,325	$2,945,000	$3,882,651	$18,375,603
MONTBELLO	PR-7	$11,890,797	$0	$657,836	$2,378,159	$3,751,800	$5,019,453	$23,698,045
		$32,130,920	$2,202,080	$3,146,264	$6,613,210	$10,319,000	$14,991,706	$69,403,179

NOTES: 1./ CONTINGENCIES, ENGINEERING, AND ADMINISTRATION FOR MASTER PLANNING ARE 40% OF DRAINAGE IMPROVEMENTS, STREET CROSSINGS, AND DETENTION STORAGE.

2./ COMMERCE CITY COSTS ARE FOR 100-YEAR CHANNELIZATION OF THE MAIN BRANCH ONLY.

ALTERNATIVE PLAN COST SUMMARY-IRONDALE GULCH

FILE:\ARSNL\FIRSTEVAL.WK1

PLANNING REACH	JURISDICT	CHANNEL OPTION	RATING	ENGINEERING SUB-TOTAL	ENGINEERING RELATIVE RATING	ENVIRON/AESTHETIC SUB-TOTAL	ENVIRON/AESTHETIC *RELATIVE RATING	GRAND TOTALS
D 1	COMMERCE CITY				60		40	
		ENG FLDWY	*Rating					
			*Comb. Rtng.	92		58		78
		ENG WTLND	*Rating					
			*Comb. Rtng.	80		97		87
		*OPEN SPC	*Rating					
			*Comb. Rtng.	61		125		87
NO 2	COMMERCE CITY				70		30	
		ENG FLDWY	*Rating					
			*Comb. Rtng.	93		54		81
		ENG WTLND	*Rating					
			*Comb. Rtng.	82		86		83
		*OPEN SPC	*Rating					
			*Comb. Rtng.	55		101		69
NO 3	COMMERCE CITY				30		70	
		ENG FLDWY	*Rating					
			*Comb. Rtng.	105		36		57
		ENG WTLND	*Rating					
			*Comb. Rtng.	90		46		59
		*OPEN SPC	*Rating					
			*Comb. Rtng.	64		119		103
NO 4	ARSENAL				50		50	
		ENG FLDWY	*Rating					
			*Comb. Rtng.	104		29		67
		ENG WTLND	*Rating					
			*Comb. Rtng.	84		39		62
		*OPEN SPC	*Rating					
			*Comb. Rtng.	64		42		53

TABLE VI-6A

FILE:\ARSNL\FIRSTEVAL.WK1

PLANNING REACH	JURISDICT	CHANNEL OPTION	RATING	ENGINEERING SUB-TOTAL	ENGINEERING RELATIVE RATING	ENVIRON/AESTHETIC SUB-TOTAL	ENVIRON/AESTHETIC *RELATIVE RATING	GRAND TOTALS
NO 5	ARSENAL				60		40	
		ENG FLDWY	*Rating					
			*Comb. Rtng.	103		32		75
		ENG WTLND	*Rating					
			*Comb. Rtng.	85		37		66
		*OPEN SPC	*Rating					
			*Comb. Rtng.	66		83		73
NO 6	FIRST CR RNCH				60		40	
		ENG FLDWY	*Rating					
			*Comb. Rtng.	107		34		78
		ENG WTLND	*Rating					
			*Comb. Rtng.	72		40		59
		*OPEN SPC	*Rating					
			*Comb. Rtng.	58		107		78
NO 7	FIRST CR RNCH				30		70	
		ENG FLDWY	*Rating					
			*Comb. Rtng.	91		41		56
		ENG WTLND	*Rating					
			*Comb. Rtng.	71		46		54
		*OPEN SPC	*Rating					
			*Comb. Rtng.	78		112		102
NO 9	GREEN VL RNCH				30		70	
		ENG FLDWY	*Rating					
			*Comb. Rtng.	93		34		52
		ENG WTLND	*Rating					
			*Comb. Rtng.	71		46		54
		*OPEN SPC	*Rating					
			*Comb. Rtng.	78		112		102
	TOTALS	ENG FLDWY		787		318		543
		ENG WTLND		634		437		522
		OPEN SPC		524		801		665

SUMMARY EVALUATION MATRIX - FIRST CREEK

FILE:\ARSNL\8791RTE.WK1 IRONDALE GULCH PLAN NO 1 (W/O MINI-REGIONAL DETENTION)

PLANNING REACH	JURISDICT	RATING	ENGINEEERING SUB-TOTAL	ENGINEEERING RELATIVE RATING	ENVIRON/AESTHETIC SUB-TOTAL	ENVIRON/AESTHETIC RELATIVE RATING	GRAND TOTALS
NO 1	COMMERCE CITY			80		20	117
		Rating					
		Comb. Rtng.	126		64		
NO 2	ARSENAL			40		60	91
		Rating					
		Comb. Rtng.	111		61		
NO 3	ARSENAL			60		40	90
		Rating					
		Comb. Rtng.	113		44		
NO 4	ARSENAL			10		90	97
		Rating					
		Comb. Rtng.	129		73		
NO 5	ARSENAL			70		30	112
		Rating					
		Comb. Rtng.	117		77		
NO 6	ARSENAL			50		50	92
		Rating					
		Comb. Rtng.	105		61		
NO 7	DENVER/AURORA			40		60	132
		Rating					
		Comb. Rtng.	147		95		
	TOTALS		848		475		732

TABLE Vi-7A

FILE:\ARSNL\8791RTE.WK1 IRONDALE GULCH PLAN NO 2 (W/O MINI-REGIONAL DETENTION)

PLANNING REACH	JURISDICT	RATING	ENGINEEERING SUB-TOTAL	ENGINEEERING RELATIVE RATING	ENVIRON/AESTHETIC SUB-TOTAL	ENVIRON/AESTHETIC RELATIVE RATING	GRAND TOTALS
NO 1	COMMERCE CITY			80		20	110
		Rating					
		Comb. Rtng.	117		64		
NO 2	ARSENAL			40		60	88
		Rating					
		Comb. Rtng.	102		61		
NO 3	ARSENAL			60		40	87
		Rating					
		Comb. Rtng.	107		44		
NO 4	ARSENAL			10		90	96
		Rating					
		Comb. Rtng.	112		73		
NO 5	ARSENAL			70		30	107
		Rating					
		Comb. Rtng.	111		77		
NO 6	ARSENAL			50		50	101
		Rating					
		Comb. Rtng.	96		83		
NO 7	DENVER/AURORA			40		60	128
		Rating					
		Comb. Rtng.	136		95		
	TOTALS		781		497		717

SUMMARY EVALUATION MATRIX - IRONDALE GULCH

FILE:\ARSNL\8791RTE.WK1 IRONDALE GULCH PLAN NO 3 (W/O MINI-REGIONAL DETENTION)

PLANNING REACH	JURISDICT	RATING	ENGINEEERING SUB-TOTAL	ENGINEEERING RELATIVE RATING	ENVIRON/AESTHETIC SUB-TOTAL	ENVIRON/AESTHETIC RELATIVE RATING	GRAND TOTALS
NO 1	COMMERCE CITY			80		20	108
		Rating					
		Comb. Rtng.	115		64		
NO 2	ARSENAL			40		60	89
		Rating					
		Comb. Rtng.	104		61		
NO 3	ARSENAL			60		40	86
		Rating					
		Comb. Rtng.	106		44		
NO 4	ARSENAL			10		90	96
		Rating					
		Comb. Rtng.	111		73		
NO 5	ARSENAL			70		30	88
		Rating					
		Comb. Rtng.	77		88		
NO 6	ARSENAL			50		50	86
		Rating					
		Comb. Rtng.	94		61		
NO 7	DENVER/AURORA			40		60	125
		Rating					
		Comb. Rtng.	130		95		
	TOTALS		737		486		678

FILE:\ARSNL\8791RTE.WK1 IRONDALE GULCH PLAN NO 4 (W/O MINI-REGIONAL DETENTION)

PLANNING REACH	JURISDICT	RATING	ENGINEEERING SUB-TOTAL	ENGINEEERING RELATIVE RATING	ENVIRON/AESTHETIC SUB-TOTAL	ENVIRON/AESTHETIC RELATIVE RATING	GRAND TOTALS
NO 1	COMMERCE CITY			80		20	101
		Rating					
		Comb. Rtng.	106		64		
NO 2	ARSENAL			40		60	85
		Rating					
		Comb. Rtng.	95		61		
NO 3	ARSENAL			60		40	80
		Rating					
		Comb. Rtng.	96		44		
NO 4	ARSENAL			10		90	95
		Rating					
		Comb. Rtng.	105		73		
NO 5	ARSENAL			70		30	98
		Rating					
		Comb. Rtng.	92		88		
NO 6	ARSENAL			50		50	88
		Rating					
		Comb. Rtng.	92		66		
NO 7	DENVER/AURORA			40		60	121
		Rating					
		Comb. Rtng.	120		95		
	TOTALS		706		491		670

SUMMARY EVALUATION MATRIX - IRONDALE GULCH

November 15, 1988 FILE: LOTUS\FORMS\UNITCOST.WK1

RIGHT OF WAY ACQUISITION		
OPEN SPACE	ACRE	$40,000
RESIDENTIAL LOW DENSITY	ACRE	$88,000
RESIDENTIAL MEDIUM DENSITY	ACRE	$111,000
RESIDENTIAL HIGH DENSITY	ACRE	$174,000
COMMERCIAL	ACRE	$252,000
INDUSTRIAL	ACRE	$163,000

CHANNEL AND HYDRAULIC STRUCTURES		
EXCAVATION CHANNEL	CUBIC YARD	$7.50
EXCAVATION STRUCTURAL	CUBIC YARD	$9.00
EXCAVATION DETENTION	CUBIC YARD	$2.50
BACKFILL CHANNEL	CUBIC YARD	$12.00
BACKFILL STRUCTURAL	CUBIC YARD	$15.00
RIPRAP TYPE L	TON	$25.00
RIRAP TYPE M	TON	$30.00
RIPRAP TYPE H	TON	$35.00
RIPRAP TYPE VH	TON	$40.00
RIPRAP CHANNEL LINING	SQUARE FT	$5.00
FILTER MATERIAL	TON	$25.00
CONCRETE	CUBIC YARD	$225.00
CONCRETE STRUCTURAL	CUBIC YARD	$450.00
CONCRETE TRICKLE CHANNEL	LINEAR FT	$40.00
SEEDING AND MULCHING	SQUARE FT	$0.15
SOD	SQUARE FT	$0.50

SEWER CONSTRUCTION		
MANHOLES (DIA < 66")	EACH	$4,000.00
ASPHALT PAVE. REPLACEMENT	SQUARE YRD	$25.00
CURB, GUTTER, SIDEWALK	LINEAR FT	$25.00
INLETS TYPE R - 5 FT	EACH	$3,000.00
INLETS TYPE R - 10 FT	EACH	$4,500.00
INLETS TYPE R - 15 FT	EACH	$6,000.00
STORM SEWER (RCP-III) 24 INCHES	LINEAR FT	$25.00
STORM SEWER (RCP-III) 30 INCHES	LINEAR FT	$42.00
STORM SEWER (RCP-III) 36 INCHES	LINEAR FT	$58.00
STORM SEWER (RCP-III) 42 INCHES	LINEAR FT	$67.00
STORM SEWER (RCP-III) 48 INCHES	LINEAR FT	$80.00
STORM SEWER (RCP-III) 54 INCHES	LINEAR FT	$100.00
STORM SEWER (RCP-III) 60 INCHES	LINEAR FT	$120.00
STORM SEWER (RCP-III) 72 INCHES	LINEAR FT	$160.00
STORM SEWER (RCP-III) 78 INCHES	LINEAR FT	$200.00
STORM SEWER (RCP-III) 84 INCHES	LINEAR FT	$230.00

CULVERTS		
REINFORCED CONCRETE BOX		
6 FT X 6 FT	LINEAR FT	$200.00
8 FT X 6 FT	LINEAR FT	$240.00
10 FT X 6 FT	LINEAR FT	$270.00
8 FT X 8 FT	LINEAR FT	$290.00
10 FT X 8 FT	LINEAR FT	$320.00
12 FT X 8 FT	LINEAR FT	$430.00
10 FT X 10 FT	LINEAR FT	$450.00
12 FT X 10 FT	LINEAR FT	$480.00

UNIT COSTS FOR MAJOR DRAINAGEWAY PLANNING

REINFORCED CONCRETE PIPE		
48 INCH CLASS III	LINEAR FT	$80.00
54 INCH CLASS III	LINEAR FT	$100.00
60 INCH CLASS III	LINEAR FT	$120.00
72 INCH CLASS III	LINEAR FT	$160.00
84 INCH CLASS III	LINEAR FT	$230.00

UTILITY RELOCATION		
AT CULVERTS - LOCAL STREET	EACH	$20,000.00
AT CULVERTS - COLLECTOR STREET	EACH	$40,000.00
AT CULVERTS - ARTERIAL STREET	EACH	$70,000.00
GAS LINE	EACH	$4,000.00
WATER LINE DIA < 16 INCHES	EACH	$10,000.00
WATER LINE DIA > 16 INCHES	EACH	$30,000.00
SANITARY SEWER - GRAVITY	LINEAR FT	$50.00
SANITARY SEWER - PRESSURE	LINEAR FT	$200.00

ANNUAL OPERATION AND MAINTENANCE		
GRASS CHANNEL	LINEAR FT	$4.50
CONRETE CHANNEL	LINEAR FT	$3.00
STORM SEWER	LINEAR FT	$1.00
RIPRAP PROTECTION	LINEAR FT	$2.00
DETENTION AREAS - PASSIVE PARK	ACRE	$750.00
DETENTION AREAS - NON-RECREATIONAL	ACRE	$400.00
HYDRAUL. STRUCT. - CULVERTS, ETC	EACH	$750.00
HYDRAUL. STRUCT. - CHECK DROPS	EACH	$400.00
LOW FLOW CHANNEL	LINEAR FT	$2.00

GENERAL NOTES

PROPERTY ACQUISITION: average conditions experienced during drainage construction

EXCAVATION: reflects the difficulties encountered when operating heavy equipment in a drainageway and the problems of access to the drainageway.

EMBANKMENT: reflects the nominal compaction effort (ie: 95% Standard Proctor Density) using small to medium size equipment.

RIPRAP: reflects the cost of delivery and installation of riprap

RIPRAP CHANNEL LINING: reflects the cost of delivery and installation of riprap ranging in size from 4" to 21". Cost includes excavation, filter material, and riprap.

SEEDING AND MULCHING: reflects the cost of hydroseeding with ground preparation preparation and some manual work.

CONCRETE: includes forming and reinforcement steel

STRUCTURAL CONCRETE: includes excavation, backfill, concrete and reinforcement steel for small hydraulic structures

INLETS: furnish and install materials, including 30 linear feet of 18"rcp lateral to the storm sewer.

CONCRETE TRICKLE CHANNEL: includes 5' wide, 6" deep and 6" thick with 4" of filter material underneath.

REINFORCED CONCRETE PIPE: reflects furnishing and installation of all materials.

UTILITY RELOCATION: based on average cost of water line relocation , avoiding telephone and electric lines, and bypassing sanitary sewer lines.

UNIT PRICES

I. RELEASE RATES

THE FOLLOWING EQUATION IS USED TO CALCULATE MAXIMUM ALLOWABLE RELEASE RATES:

$Q = K (A)$

WHERE:

Q = MAXIMUM ALLOWABLE RELEASE RATE (CFS)
K = RELEASE RATE COEFFICIENT (CFS/ACRE)
A = WATERSHED AREA (ACRES)

RELEASE RATE COEFFICIENTS

DRAINAGEWAY	K_{100} (CFS/AC)	K_{10} (CFS/AC)
IL-3	2.2	1.0
IL-5	0.6	0.2
IR-2	1.1	0.4

II. VOLUME REQUIREMENTS

THE FOLLOWING EQUATION IS USED TO CALCULATE THE MINIMUM VOLUME REQUIREMENTS:

$V = K (I) / 12$

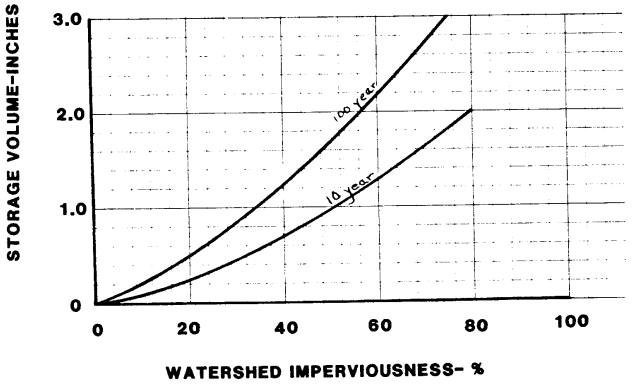
WHERE:

V = MINIMUM STORAGE VOLUME (ACRE FEET)
K = STORAGE COEFFICIENT (INCHES)
I = WATERSHED IMPERVIOUS PERCENTAGE

THE STORAGE COEFFICIENT IS OBTAINED FROM THE FIGURE BELOW:

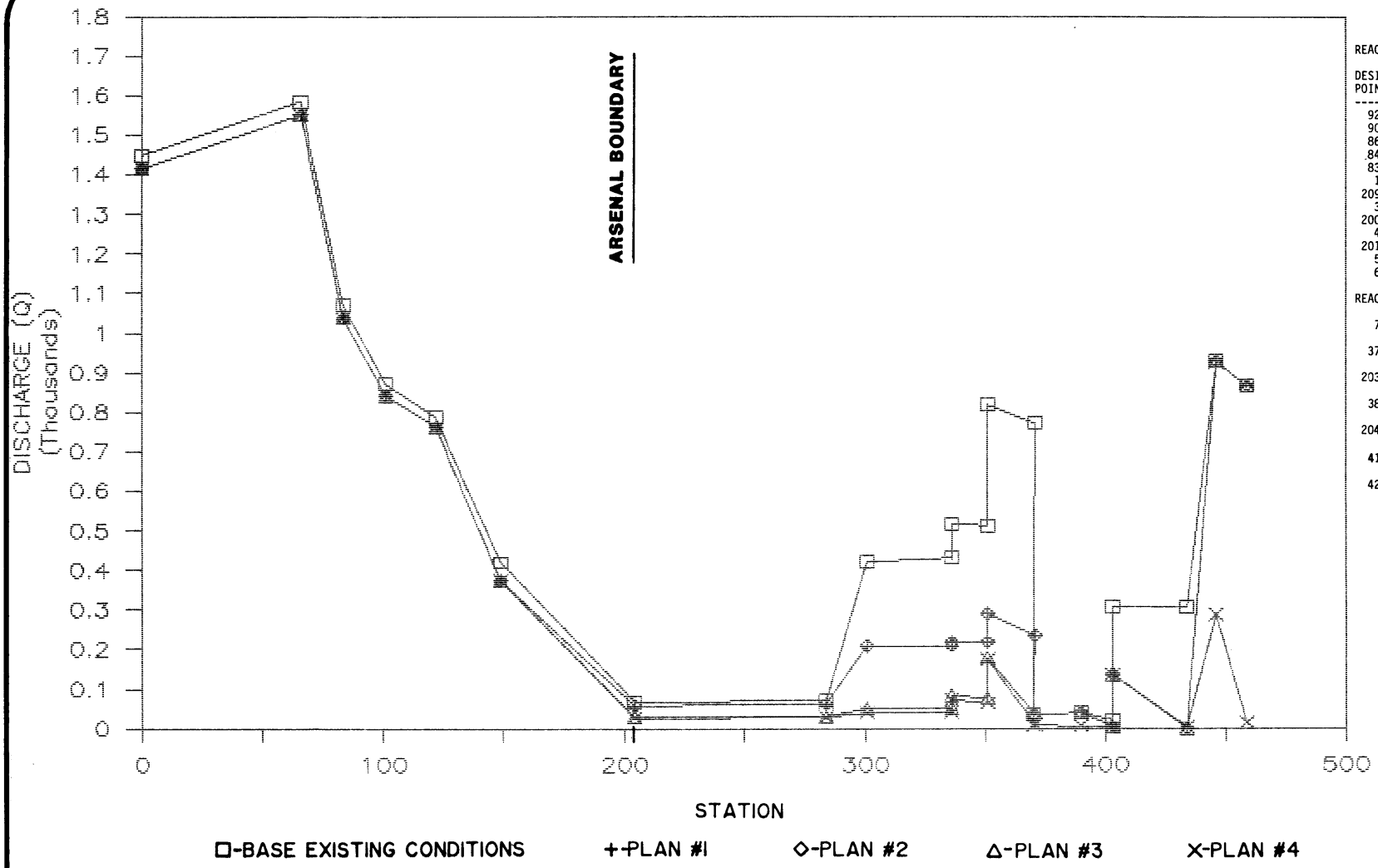
ON-SITE DETENTION REQUIREMENTS

UPPER IRONDALE GULCH



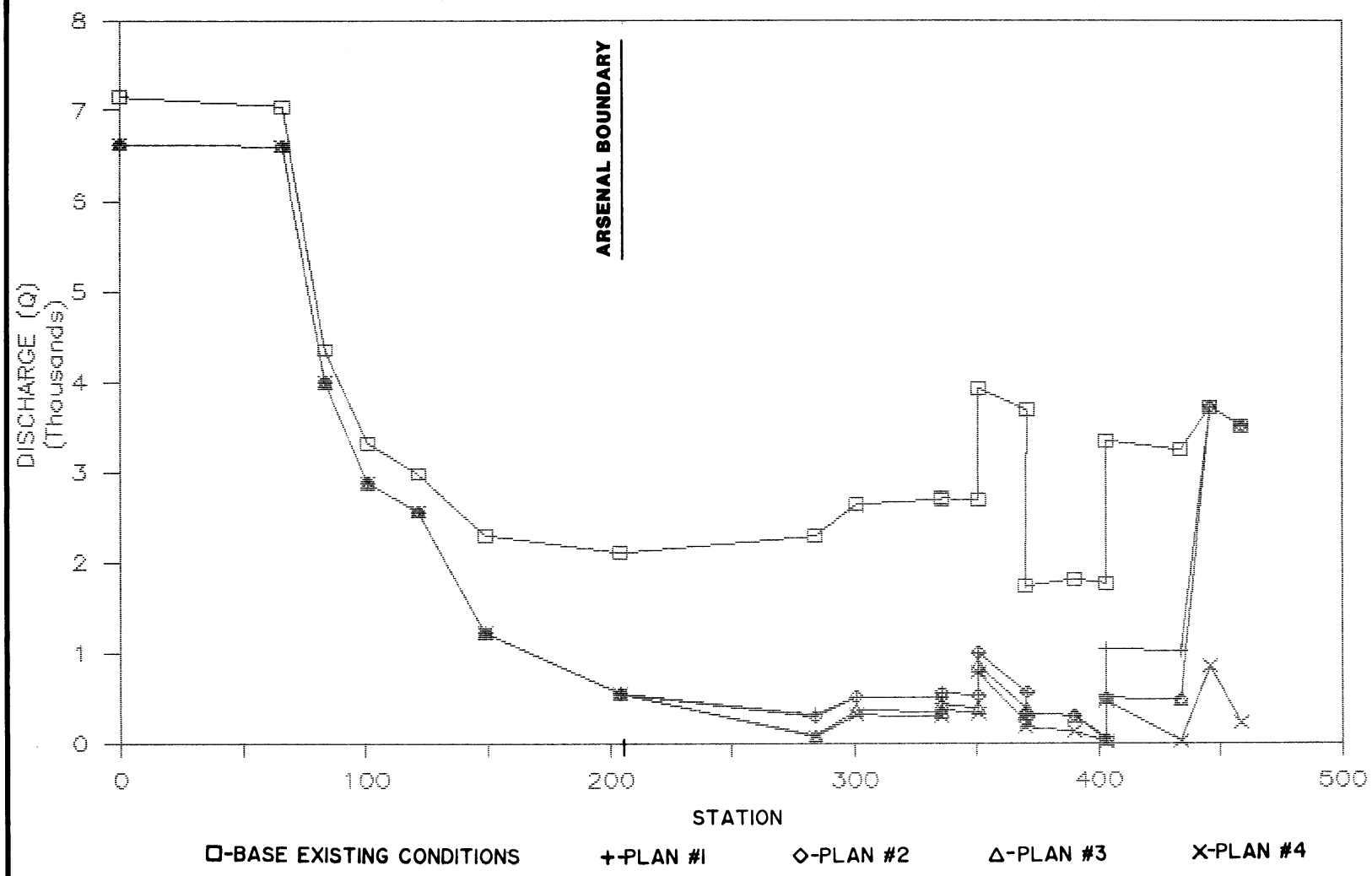
ONSITE DETENTION REQUIREMENTS-IRONDALE GULCH

FIGURE VI-1



PEAK FLOWS FOR ALTERNATIVES-LOWER IRONDALE GULCH
2 YEAR

FIGURE VI-2



LEGEND

REACH I

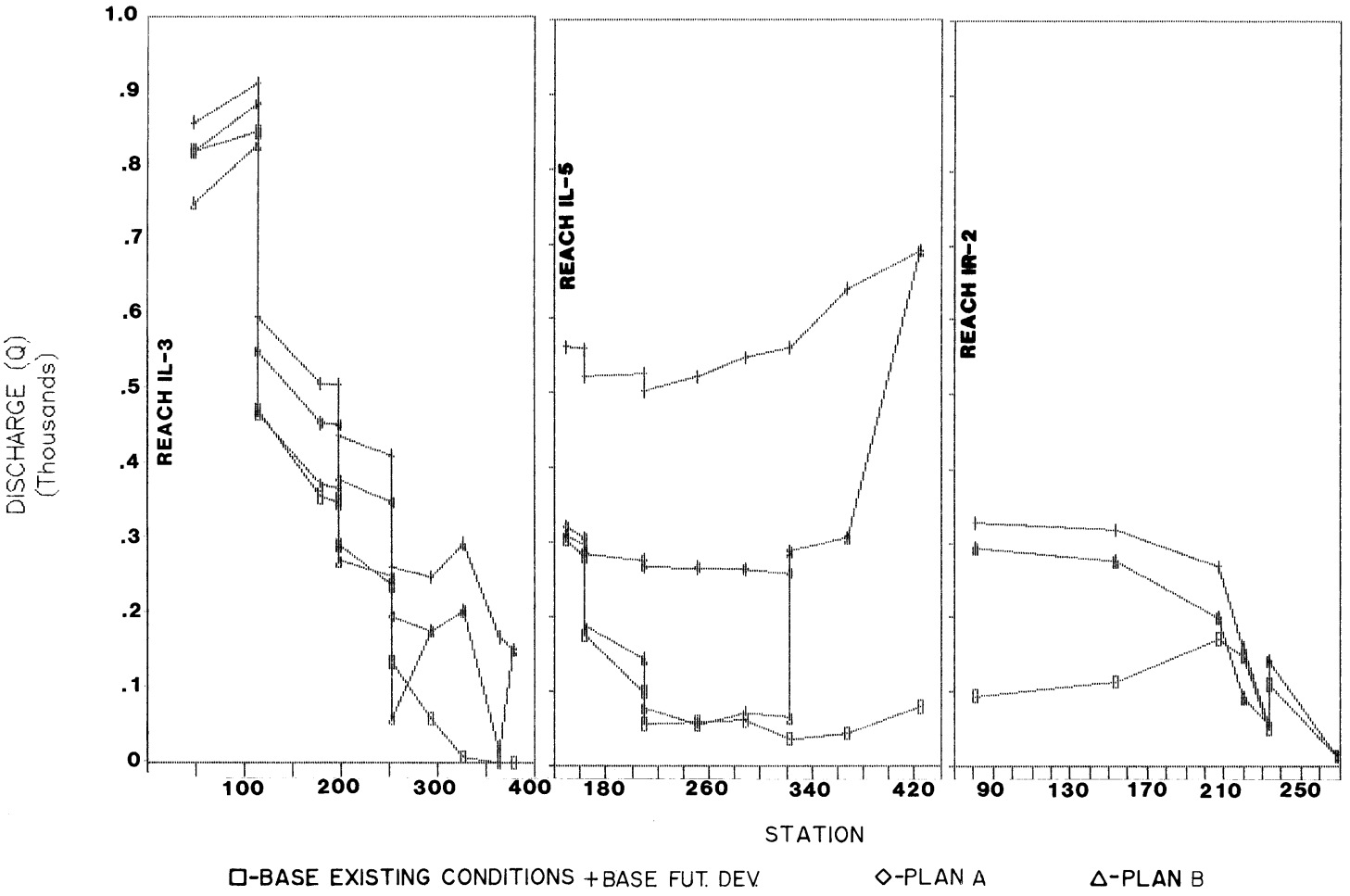
DESIGN POINT	STATION (100 ft)	LOCATION
92	0	SOUTH of PLATTE RIVER
90	66	NORTH of 88th AVENUE
86	84	INTERSTATE 76
84	101	EAST of 88th AVENUE
83	122	U.P.R.R.
1	149	EAST of 88th AVENUE
209	284	RR LAKE
3	301	SOUTH of 72nd AVENUE
200	336	MARY OUT
4	336	MARY IN
201	351	LADORA OUT
5	351	LADORA IN
6	371	EAST of 64th AVENUE

REACH IL-5

7	0	
	371	EAST of 64th AVENUE
37	20	
	391	PEORIA
203	33	
	404	LOWER DERBY
38	33	
	404	LOWER DERBY
204	64	
	435	UPPER DERBY
41	76	
	447	UPPER DERBY
42	89	
	460	EAST of 64th AVENUE

PEAK FLOWS FOR ALTERNATIVES-LOWER IRONDALE GULCH 100 YEAR

FIGURE VI-3

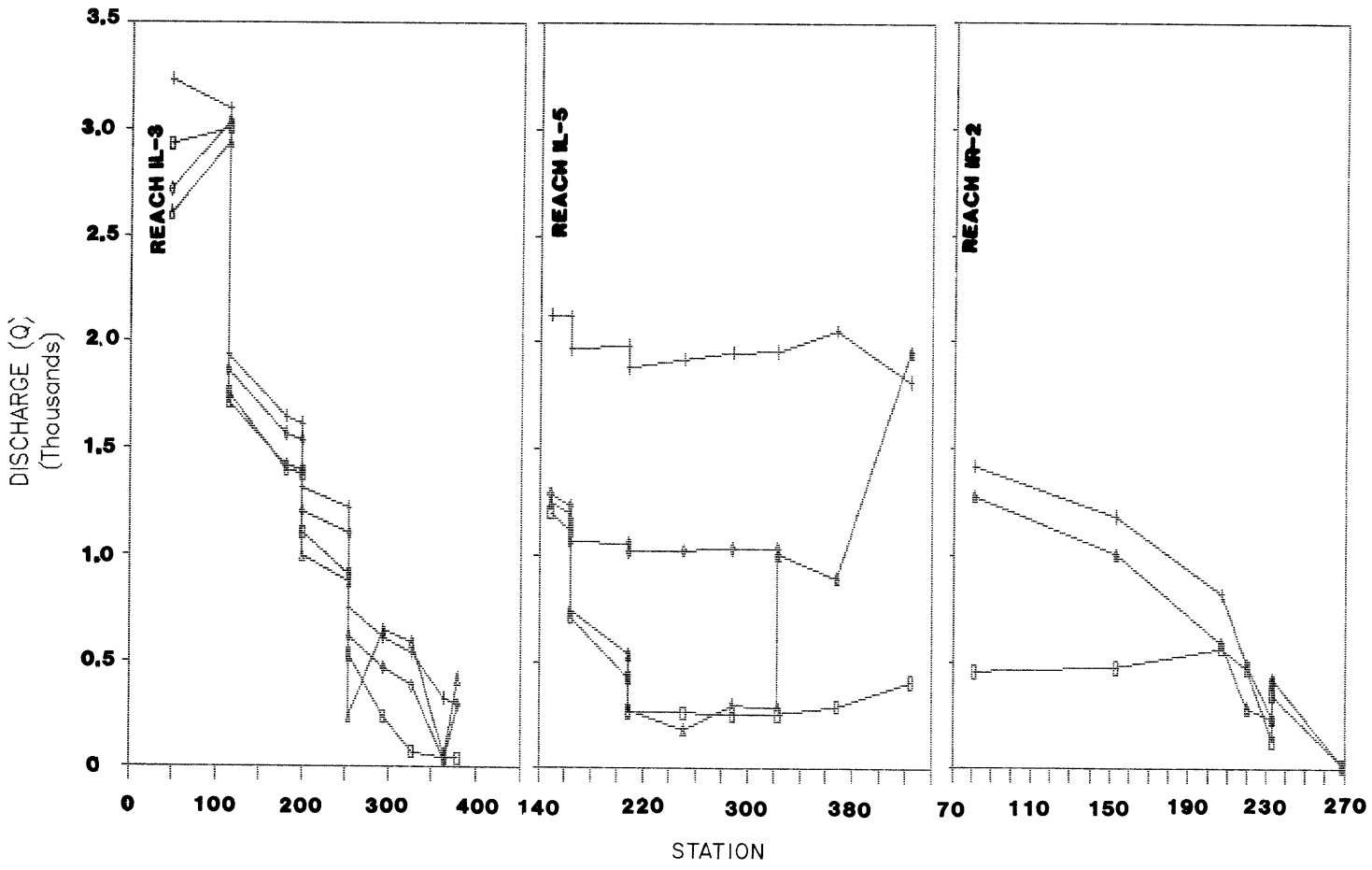


	Design Point	Station	Comments
REACH IL-3	74	48	Havana
	16	114	Hanana
	17	114	Havana
	25	180	Peoria
	26	199	Section 13
	27	199	Section 13
	29	254	Havana
	30	254	Havana
	33	294	Chambers
	34	327	East of Chambers
	158	364	Downstream of Row Pond
	213	364	Row Pond
	35	379	West of Tower
REACH IL-5	51	149	Arsenal Boundary
	52	164	Section 13
	54	164	Section 13
	56	209	Section 18
	62	209	Section 18
	57	251	Chambers
	58	288	East of Chambers
	212	323	Row Pond
	59	323	West of Tower
	60	368	Tower Road
	61	424	Sky Airport
REACH IR-2	67	81	Chambers
	71	153	West of Tower
	72	207	Tower Road
	73	220	East of Tower
	205	233	Green Valley Ranch
	77	233	Section 22
	206	269	Green Valley Ranch

PEAK FLOWS FOR ALTERNATIVES-UPPER IRONDALE GULCH

2 YEAR

FIGURE VI-4



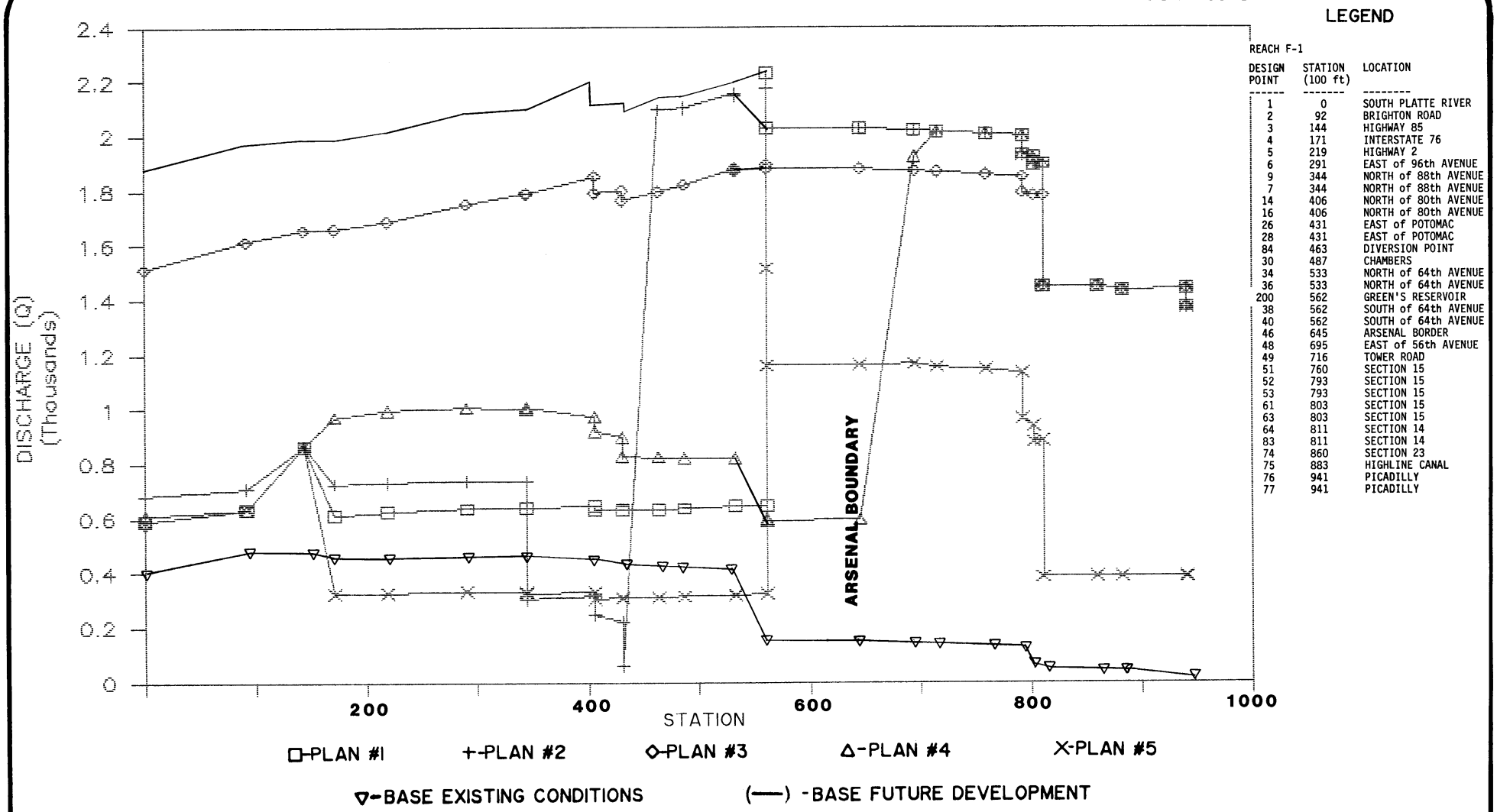
	Design Point	Station	Comments
REACH IL-3	74	48	Havana
	16	114	Hanana
	17	114	Havana
	25	180	Peoria
	26	199	Section 13
	27	199	Section 13
	29	254	Havana
	30	254	Havana
	33	294	Chambers
	215	251	CHAMBERS 1
	34	327	East of Chambers
	158	364	Downstream of Row Pond
	213	364	Row Pond
	35	379	West of Tower
REACH IL-5	51	149	Arsenal Boundary
	52	164	Section 13
	54	164	Section 13
	56	209	Section 18
	62	209	Section 18
	57	251	Chambers
	216	294	CHAMBERS 2
	58	288	East of Chambers
	212	323	Row Pond
	59	323	West of Tower
	60	368	Tower Road
	61	424	Sky Airport
REACH IR-2	67	81	Chambers
	71	153	West of Tower
	72	207	Tower Road
	73	220	East of Tower
	205	233	Green Valley Ranch
	77	233	Section 22
	206	269	Green Valley Ranch

□-BASE EXISTING CONDITIONS ◇-PLAN A △-PLAN B + -BASE FUTURE DEVELOPMENT

PEAK FLOWS FOR ALTERNATIVES-UPPER IRONDALE GULCH

100 YEAR

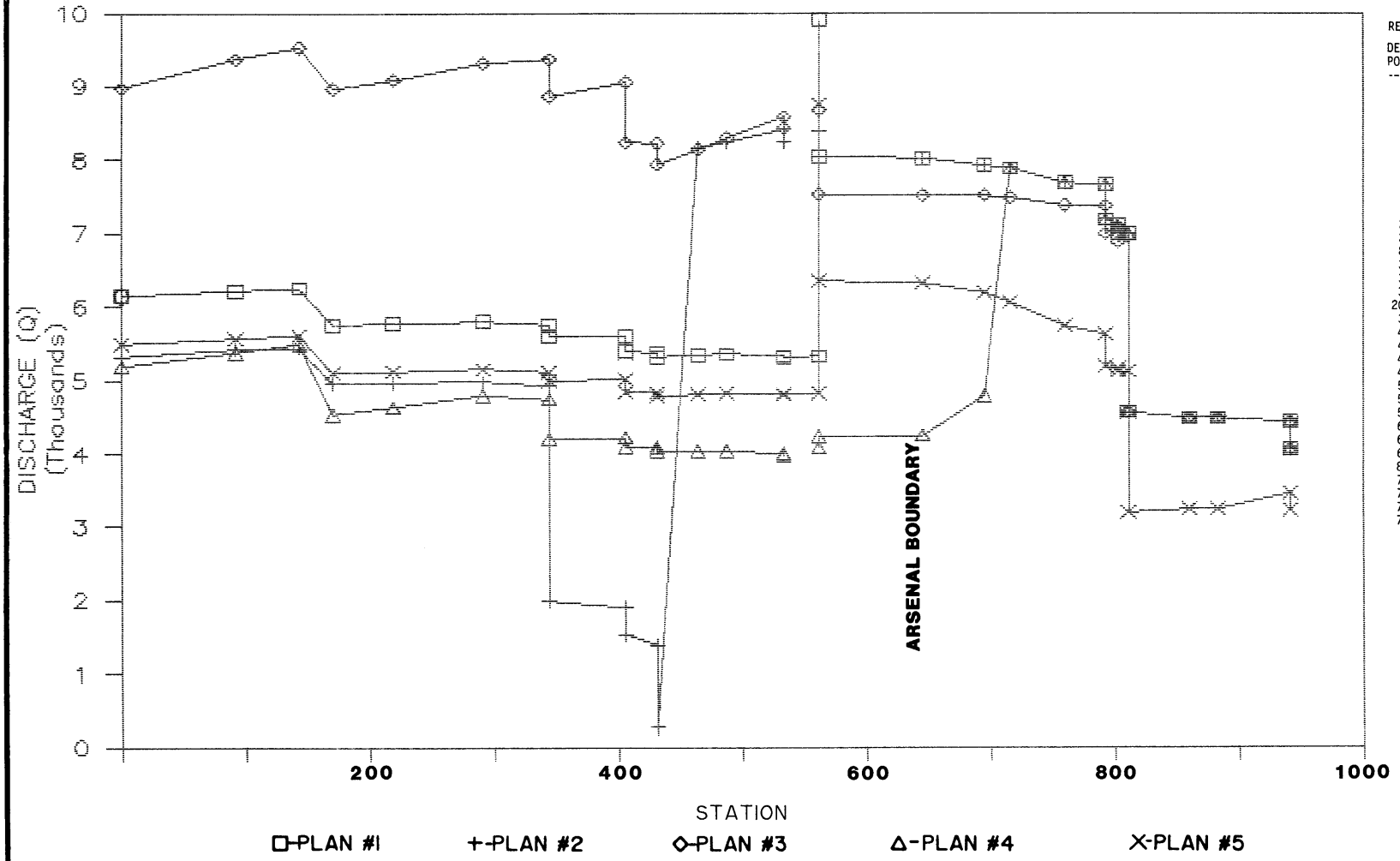
FIGURE VI-5



PEAK FLOWS FOR ALTERNATIVES-FIRST CREEK PLAN 1-5

2 YEAR

FIGURE VI-6



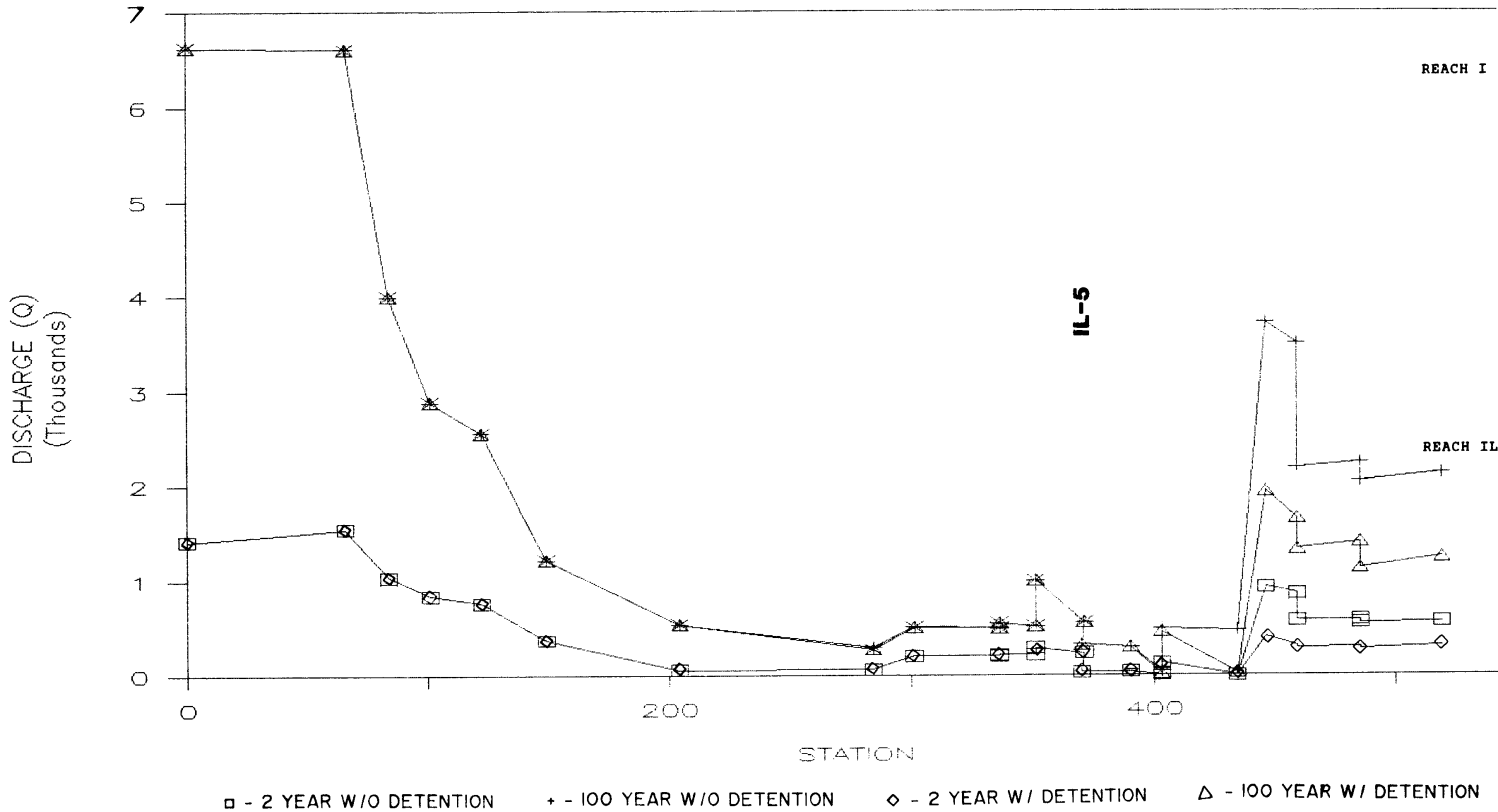
LEGEND

REACH F-1

DESIGN POINT	STATION (100 ft)	LOCATION
1	0	SOUTH PLATTE RIVER
2	92	BRIGHTON ROAD
3	144	HIGHWAY 85
4	171	INTERSTATE 76
5	219	HIGHWAY 2
6	291	EAST of 96th AVENUE
9	344	NORTH of 88th AVENUE
7	344	NORTH of 88th AVENUE
14	406	NORTH of 80th AVENUE
16	406	NORTH of 80th AVENUE
26	431	EAST of POTOMAC
28	431	EAST of POTOMAC
84	463	DIVERSION POINT
30	487	CHAMBERS
34	533	NORTH of 64th AVENUE
36	533	NORTH of 64th AVENUE
200	562	GREEN'S RESERVOIR
38	562	SOUTH of 64th AVENUE
40	562	SOUTH of 64th AVENUE
46	645	ARSENAL BORDER
48	695	EAST of 56th AVENUE
49	716	TOWER ROAD
51	760	SECTION 15
52	793	SECTION 15
53	793	SECTION 15
61	803	SECTION 15
63	803	SECTION 15
64	811	SECTION 14
83	811	SECTION 14
74	860	SECTION 23
75	883	HIGHLINE CANAL
76	941	PICADILLY
77	941	PICADILLY

PEAK FLOWS FOR ALTERNATIVES-FIRST CREEK PLAN 1-5 100 YEAR

FIGURE VI-7



	DESIGN POINT	STATION (100 FT)	COMMENTS
REACH I	92	0	SOUTH OF PLATTE RIVER
	90	66	NORTH OF 88TH AVENUE
	86	84	INTERSTATE 76
	84	101	EAST OF 88TH AVENUE
	83	122	UP RAILROAD
	82	149	EAST OF 88TH AVENUE
	1	204	ARSENAL BOUNDRY
	209	284	R R LAKE
	3	301	SOUTH OF 72ND AVENUE
	200	336	MARY OUT
	4	336	MARY IN
	201	351	LADORA OUT
	5	351	LADORA IN
	6	371	EAST OF 64TH AVENUE
REACH IL-5			
	7	0	
		371	EAST OF 64TH AVENUE
	37	20	
		391	PEORIA
	203	33	
		404	LOWER DERBY
	38	33	
		404	LOWER DERBY
	204	64	
		435	UPPER DERBY
	41	76	
		447	UPPER DERBY
	42	89	
		460	EAST OF 64TH AVENUE
	44	89	
		460	EAST OF 64TH AVENUE
	45	115	
		486	SECTION 12
	47	115	
		486	SECTION 12
	51	149	
		520	ARSENAL BOUNDRY

AFFECTS OF REGIONAL DETENTION IN UPPER IRONDALE GULCH

SECTION VII

CONCLUSIONS

AND

RECOMMENDATIONS

SECTION - VII

CONCLUSIONS AND RECOMMENDATIONS

A. GENERAL CONCLUSIONS

The urbanization of rural land inevitably increases the amount of stormwater runoff and thus the need for master planning and channel protection measures. This study has shown that First Creek and Irondale Gulch watersheds will require extensive channel improvements with emphasis on erosion control. With full development, flood peaks could increase from 2 to 3 times for the major flood and up to 6 times for the minor floods. The resulting impact of increased flood peaks, frequency of occurrence and overall volume will be significant.

In addition to the increased flood peaks, the increase in base flow from urbanization will cause extensive channel degradation if not properly controlled. Base flow is the regularly recurring runoff from summer showers, snow melt and lawn watering. Water imported to the basins for use in landscape irrigation will also contribute to the base flow. The base flow is expected to increase in magnitude, frequency of occurrence and duration. The combination of these three factors can cause extensive erosion, as already witnessed in a tributary to First Creek which receives the wastewater from the Highline Canal.

The large majority of urbanization is projected to occur upstream of the Rocky Mountain Arsenal (RMA). Since the RMA will be in a clean-up phase for some time and possibly never urbanize, the existing channels and facilities must be protected from the increased base and flood flows, which can cause erosion, sedimentation and environmental impact.

The adequacy of existing facilities was discussed in Section IV. The evaluation emphasized the need for improvements to existing road crossings, channels, and other hydraulic structures to mitigate future runoff impacts.

In Section V, the development of the alternatives was discussed. Specific constraints on the solutions were presented and included: (1) the clean up and the environmental limitations within the RMA, which requires extensive control of surface runoff, (2) the lack of an outfall through the Commerce City area, (3) the lack of adequate drainage facility capacity in the Montbello area and the lower reaches of First Creek, (4) the intense development along the Airport Boulevard corridor, which will compete with the land area needed to preserve wetlands and construct large regional detention sites, (5) the increased base flows and the subsequent erosion of the channels, particularly First Creek, which requires control of the minor storm flow, and (6) the projected urbanization within the Aurora annexation area. This section became the basis for both the development and evaluation of alternatives.

B. IRONDALE GULCH

The recommendations for Irondale Gulch are as follows:

(a) The adoption of Plan 2 (Drawing 10B), which maximizes the utilization of the existing storage facilities on the RMA to control both the base flows and major floods, provides for enhanced control of the surface runoff and protects the natural channels and the adjacent wildlife habitat.

(b) The adoption of Plan B (Drawing 10B), which utilizes mini-regional detention in the upper Irondale Gulch watershed (ie: upstream of Chambers Road) along with channelization to reduce the future developed peak flows to existing development levels.

(c) Improvements to the channels and road crossings within Montbello to pass the fully developed (with detention in the upper reaches) 10-year flood peaks. This will provide residual capacity in the adjacent streets to convey the 100-year flood, except for tributary IL-3 (see Drawing 6).

The cost of the recommended alternative for Irondale Gulch is presented in Table VII-2. The justifications for the above recommendations are presented below.

1. Upper Irondale Gulch

The proposed plan for the upper reaches of the watershed provides for mini-regional detention facilities in each of the tributaries in the vicinity of the proposed Airport Boulevard right-of-way and at Chambers Road. Mini-regional detention is defined as detention which serves more than the adjacent property but on a smaller scale than regional detention for the entire watershed. These detention facilities are important to controlling the impact on the existing undersized structures in Montbello. The precise location and configuration of the proposed detention facilities are not critical, although the facilities will need to be reasonably close to Chambers Road. Alternate detention locations and configurations have been investigated (Reference 32) and have been found to have similar peak flow reduction benefits to the plan presented herein.

As an option to the mini-regional detention in upper Irondale Gulch, the use of onsite detention was investigated. The criteria for onsite detention is presented in Table VI-9 and discussed in Section VI-B.3. Facilities were sized based on a typical 10 acre development and cost estimates prepared. A summary of these costs is presented below:

ONSITE DETENTION COST SUMMARY
UPPER IRONDALE GULCH

BASIN	DEVELOP. ACRES	VOLUME REQ'D (AF)	NO OF 10 AC PONDS	CONST COSTS (1000$)	ROW ACRES	ROW COSTS (1000$)	TOTAL COSTS (1000$)
IL-3	350	34	35	$1,575	24	$ 4,176	$ 5,751
IL-5	820	131	82	$3,690	92	$16,008	$19,698
IR-2	500	54	50	$2,250	38	$ 6,612	$ 8,862
TOTALS	**1670**	**219**	**167**	**$7,515**	**154**	**$26,796**	**$34,311**

Comparing these costs to the cost for detention presented in Table VI-5B for Plan 2, the cost for onsite detention is considerable higher than the cost for regional detention. For instance, utilizing Plan 2 for lower Irondale Gulch and Plan B for upper Irondale Gulch, the "DETENTION STORAGE" costs from Table VI-5B are $ 657,836 in "PLANNING REACH" PR-7 without land costs and $ 4,409,636 with land costs. This compares with $ 7,515,000 without land costs and $ 34,311,000 with land costs using onsite detention.

The existing drainage system within the Montbello area has capacity for the 2-year to 5-year flood, under existing development conditions, which will decrease to about the 2-year or less under full development. With mini-regional detention (Plan B) and increasing the capacity to a 10-year system, the residual flood (ie: between the 10-year and the 100-year) can generally be conveyed within the adjacent street section, except for tributary IL-3. The difference in cost between the 5-year system and the 10-year system is minimal, because most of the construction costs are associated with removal and replacement of the existing facilities. Therefore, WWE recommends the 10-year system for the Montbello area.

2. Commerce City Area

The Commerce City area of Irondale Gulch is somewhat buffered from the urbanization impacts on stormwater facilities by the large area of undeveloped land in the RMA (see section IV). The problems and thus the solutions of inadequate storm drainage facilities are local to Commerce City. The flood peaks developed in this study are similar to those used to evaluate and size the facilities within the Commerce City area.

One of the most important aspects of the improvements within Commerce City is the provision of an outfall storm sewer to pass the runoff from the RMA and upper areas of Irondale Gulch. The outfall will be vital to the clean-up program on the RMA because it will provide an outfall for the storm flows which do not need to be treated or are not needed for surface/groundwater control efforts to pass through the arsenal. It is therefore the recommendation of this study to implement the local solutions proposed by the McLaughlin report to address future impacts.

Infill development may or may not occur at the same time as development in the upper Irondale Gulch (Planning Reach 7), thus implementation of improvements in Commerce City may be done independently as development warrants.

3. Rocky Mountain Arsenal

The RMA is the site of several existing detention facilities. Upper Derby Lake, Railroad detention and Havana pond are an integral part of plans 1 and 2, providing flood control benefits. The remaining reservoirs (Derby Lake, Ladora Lake, and Lake Mary) are not required for flood control, but do provide control of base flows and general surface water control for the clean-up. Impact on the clean-up operation as well as erosion of the existing channel are the greatest concerns in the RMA. For this reason, both plans incorporate flexibility for routing and storage of stormwater to assist in the RMA clean-up efforts. Plan 2 reduces future impacts to a greater degree than does Plan 1, even though Plan 1 is rated higher than Plan 2 (Table VI-4).

Plans 3 and 4 are presented as an alternative to possible delays and coordination problems that may occur in using federal lands as part of a regional stormwater management plan. Plans 3 and 4 reduce dependence upon federal cooperation and involvement by diverting flows to the Stapleton Airport redevelopment area and ultimately to Sand Creek. Plan 4 involves the greatest diversion of flows and is thus the most effective of the diversion options. Plans 3 and 4 also provide for some flexibility for routing and storage of stormwater for the clean-up, but to a lesser degree and a lesser priority than for plans 1 and 2. Plans 3 and 4 were rated less than Plans 1 and 2.

To resolve which of the plans is most appropriate within the RMA, several items were considered in the selection of Plan 2:

(a) The current master plan for Sand Creek (Reference 33) identifies channel degradation as a problem. That problem may be compounded by introducing more base flows, which could be the case for Plan 3 and 4.

(b) Plan 4 requires the use of existing Stapleton Airport property for channels and a detention facility. The development of upper Irondale Gulch will likely occur prior to the time when the current airport property becomes available. This situation would present a constructability conflict for development in Irondale Gulch.

(c) Plan 2 makes the greatest use of existing facilities and is thus less expensive than Plan 4 (see Table VI-2).

(d) Diversion of flows to Sand Creek may present legal problems in regards to water rights or impacts of diverted water. The extent of these potential problems has not been investigated by this study.

(e) Plans 3 and 4 still require some improvements to the existing reservoirs within the RMA, since the diversion of runoff is only up to the 10-year recurrence interval flood.

C. FIRST CREEK BASIN

The recommendations for the First Creek watershed are as follows:

(a) The construction of regional detention as shown on Drawing 15. As an alternative to the Green's reservoir site, the developers option, located upstream (see Drawing 9) is essentially equivalent.

(b) The modification of the proposed detention reservoirs in the Aurora Annexation area to provide detention for the 2-year flood peaks.

(c) The addition of a regional detention facility at Picadilly Road for the Aurora annexation area.

(d) The combination of engineered floodway channels, engineered wetland bottom channels, and open space conveyance channels for the reaches as described in VII-1.

(e) The construction of a flow separation structure at the intersection of First Creek and the O'Brian Canal and the Burlington Ditch.

(f) The construction of 100-year road crossings at the major streets.

The costs of the recommended alternative are presented in Table VII-1. The justifications for the above recommendations are presented below.

The First Creek watershed lies east of and parallel to the Irondale Gulch watershed. The portion of the basin most likely to become urbanized also lies upstream of the RMA. The Aurora annexation study (References 1 and 2) by Simons, Li and Associates (SLA) previously assessed the storm drainage problems associated with development in the uppermost reaches of the watershed. The SLA study focused on reducing impacts to existing crossing structures within the upper basin area (ie above Picadilly Road in Aurora) and did not analyze the entire watershed to the South Platte River. The recommendation of the SLA study included several large regional detention areas.

WWE investigated the impacts of the proposed SLA detention facilities and found them to be beneficial in reducing the 100-year flood peaks within the lower reaches of First Creek. WWE recommends that the SLA detention plan be incorporated as part of the overall watershed master plan. Therefore, the plans investigated by WWE included the effects of the proposed SLA detention in Aurora.

WWE also investigated modifications to the SLA detention plan to improve the benefits in the lower reaches. The modifications made by WWE focused on reduction of peak flows during minor storms, as well as evaluating an additional detention facility at Picadilly Road for the major flood. As detailed in Section VI-A, the release rates for the proposed detention facilities were reduced to capture more of the minor storm and the Picadilly Road detention was sized to reduce the 2-year flood peaks even further.

The proposed WWE modifications reduced peak flows during the 2-year storm in the main channel (PRF-8) from approximately 1400 cfs to only 400 cfs at the SLA study limits (Aurora city boundary). Peak flows in Tributary T (PRF-10) were reduced for the 2-year and 100-year floods by 5 and 13%, respectively with the modifications, indicating some major flood benefits as well. Since, the modifications were aimed at the minor flood, it is not anticipated that the storage requirements for the major flood will be significantly increased. These modifications were found to be very cost effective and are therefore recommended as part of the WWE plan for First Creek.

The downstream reaches of First Creek (PRF-6,-7 and -9) will experience increases in runoff which, if not controlled, will cause substantial erosion, and environmental and wildlife habitat damages, as well as aggravate clean up efforts in the RMA. The Green's Reservoir and developer's detention options are effective in mitigating this impact by providing detention at the eastern or upstream boundary of the RMA. The two plans are similar in their hydraulic effectiveness, but differ in other important aspects.

The Developer's Option is so named because it was suggested at a developers meeting with the city and county of Denver. The option would allow those wishing to develop this area to proceed with the construction of a regional detention facility without the involvement of federal lands, such as for Green's Reservoir, by substituting a regional facility just upstream of the RMA boundary. Whereas the actual configuration of the Developers Option is different then suggested at the meeting, the concept is the same. The Developers' Option requires the use of highly valued land, whereas Green's Reservoir utilizes federal lands. The Developers Option does allow for multiple use open space areas which could also preserve existing wetlands vegetation and aesthetically enhance surrounding developments.

Green's Reservoir is the only option which reduces 2-year peak flows across the RMA below existing levels. This is important because of the frequent recurrence of these storms and to some degree, the reduction of the base flow problems. An additional merit is that once peak flows are reduced, only erosion control structures will be required on the RMA. The reservoir site, which was previously considered by the federal government as a reservoir location, is topographically well suited to detention and may be constructed in phases by an incremental raising of the embankment and increase in the excavated area to coincide with the density of upstream development.

The remaining flows in First Creek enter the RMA via Tributary FR-3B and would be retained in the Airport Boulevard North detention facility, which would most likely be located within the Airport Boulevard right-of-way. The Green's Reservoir detention combination is recommended by WWE as the alternative to address the runoff in this portion of the First Creek Basin.

By reducing the flood peaks below existing levels, the size of the diversion facilities at the O'Brian Canal and Burlington Ditch is reduced. However, the structure will still be large. The remaining portion of First Creek, below Colorado Highway 2, is not well defined and lies within the South Platte River floodplain. The channel improvements specified in the WWE recommended plan

(Drawings 15A & 15B) would improve this condition and also incorporate existing vegetation into open space areas and allow extension of bikeways and trails from the South Platte into this portion of Adams County.

FILE:FRSTCWWE.WK1 PROJECT: 871-090.010 DATE: 30-Aug-88

AREA	PLANNING REACH	DRAINAGE IMPROVMNTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL
		COST FOR WWE RECOMMENDED ALTERNATIVE						
HAZELTINE	PRF-1	$5,441,324	$173,677	$0	$34,735	$1,371,089	$2,246,001	$9,266,827
	PRF-2	$3,250,205	$278,083	$0	$55,617	$1,580,843	$1,411,315	$6,576,062
	PRF-3	$2,065,172	$82,596	$0	$16,519	$3,061,777	$859,107	$6,085,170
ARSENAL	PRF-4	$195,001	$0	$0	$0	$0	$78,000	$273,001
	PRF-5	$416,465	$137,928	$5,111,170	$27,586	$1,980,000	$2,266,225	$9,939,374
FRST CR RNCH	PRF-6	$4,588,409	$373,707	$0	$74,741	$3,863,653	$1,984,846	$10,885,357
	PRF-7	$3,290,693	$45,195	$0	$9,039	$5,077,571	$1,334,355	$9,756,853
AURORA	PRF-8	$0	$0	$587,700	$0	$884,000	$235,080	$1,706,780
GRN VLY RNCH	PRF-9	$737,503	$118,512	$0	$23,702	$1,299,518	$342,406	$2,521,641
AURORA	PRF-10	$0	$0	$55,000	$0	$0	$22,000	$77,000
HAZELTINE	PRF-11	$8,771,718	$151,868	$0	$30,374	$659,865	$3,569,434	$13,183,258
ARSENAL	PRF-12	$341,075	$13,982	$232,200	$2,796	$277,604	$234,903	$1,102,559
GVR/FIRST CREEK RANCH	PRF-13	$4,425,315	$171,858	$0	$34,372	$1,839,821	$1,838,869	$8,310,235
	PRF-14	$1,132,832	$0	$0	$0	$554,025	$453,133	$2,139,990
	PRF-15	$1,854,405	$53,413	$0	$10,683	$958,146	$763,127	$3,639,774
WWE TOTAL		$36,510,117	$1,600,817	$5,986,070	$320,163 (NOTE 3)	$23,407,912	$17,638,802	$85,463,881
SLA MASTER PLAN (2/)	PRF-8,10	$20,485,075	$0	$8,561,000	$3,870,060	$4,695,000	$11,283,341	$48,894,476
GRAND TOTAL		$56,995,192	$1,600,817	$14,547,070	$4,190,223	$28,102,912	$28,922,143	$134,358,357

NOTES:
1/ 40% OF DRAINAGE IMPROVEMNTS, STREET CROSSINGS, AND DETENTION STORAGE.
2/ "SLA MASTER PLAN" IS THE "CITY OF AURORA DRAINAGE MASTER PLAN, FIRST CREEK BASIN COST SUMMARY," p. 11, TABLE 2.
3/ UTILITY RELOCATION IS NOT ITEMIZED SEPARATELY BY THE SLA MASTER PLAN. THE FIGURE SHOWN HERE IS CALLED "OTHER" BY THE SLA REPORT.

RECOMMENDED ALTERNATIVE PLAN COST SUMMARY

-FIRST CREEK

PLAN 2

RESERVOIR IMPROVEMENTS AND INCREASED DETENTION

AREA	PLANNING REACH	DRAINAGE IMPROVMTS.	STREET CROSSINGS	DETENTION STORAGE	UTILITY RELOC.	LAND COST	CONTINGENCY, ENGNRG, ADMIN. (NOTE 1)	SUBTOTAL (NOTE 2)
COMMERCE CTY	PR-1	$9,840,483	$1,266,951	$0	$1,968,097	$3,195,000	$4,442,974	$20,713,505
ARSENAL	PR-2	$1,797,836	$68,472	$27,000	$473,262	$469,800	$757,323	$3,493,694
	PR-3	$302,893	$0	$2,005,714	$60,579	$73,800	$923,443	$3,366,429
	PR-4	$0	$0	$0	$0	$0	$0	$0
	PR-5	$708,245	$117,340	$1,028,571	$165,117	$1,593,000	$741,662	$4,353,935
	PR-6	$3,051,543	$112,707	$0	$642,850	$876,400	$1,265,700	$5,939,201
56TH AVE	PR-5,6	$0	$0	$0	$0	$0	$0	$0
MONTBELLO	PR-7	$11,890,797	$0	$657,836	$2,378,159	$3,751,800	$5,019,453	$23,698,045
		$27,591,798	$1,565,471	$3,719,121	$5,578,064	$9,959,800	$13,150,556	$61,564,810

NOTES: 1./ CONTINGENCIES, ENGINEERING, AND ADMINISTRATION FOR MASTER PLANNING ARE 40% OF DRAINAGE IMPROVEMENTS, STREET CROSSINGS, AND DETENTION STORAGE.

2./ COMMERCE CITY COSTS ARE FOR 100-YEAR CHANNELIZATION OF THE MAIN BRANCH ONLY.

RECOMMENDED ALTERNATIVE PLAN COST SUMMARY -IRONDALE GULCH

REFERENCES

REFERENCES

1. Drainage Basin Plan for Annexation Study Area Phase I - Development of Alternatives; Volume I, Upper South Platte Basin, Simons Li & Associates, March 1986.

2. Drainage Basin Plan Upper South Platte River Basin, Simons Li & Associates, December 1986.

3. Major Drainageway Planning, First Creek Phase B, Volume-II, Engineering Consultants, Inc., March 1977.

4. Drainage Outfall Systems Planning, Northern Commerce City and Irondale Area, McLaughlin Water Engineers, Ltd., April 15, 1986.

5. Evaluation of the Existing and Future Flood Potential on the Rocky Mountain Arsenal Denver, Colorado, U. S. Army Corps of Engineers, Omaha District, March 1983.

6. Inspection Report Rocky Mountain Arsenal Ladora Dam and Lake, Commerce City, Colorado, U.S. Army Corps of Engineers, Omaha District, July 1983 and July 1986.

7. Correspondence From the State Engineers File regarding Lower Derby Dam.

8. Interim Growth Management Plan, DRAFT, City of Aurora (copy received November 1987).

9. Comprehensive Plan, City of Aurora, Adopted 1986.

10. Storm Drainage Design and Technical Criteria Adams County, WRC Engineering, Inc., 1986 (DRAFT).

11. Subdivision Regulations, Adams County, Colorado.

12. Zoning Ordinance, City of Commerce City, June 23, 1975.

13. Master Drainage Study for Green Valley Ranch Denver Colorado, MSM Consultants, Inc, 1981 (revised), with Addendum I dated August 1981, II November 1982, III March 1983, and V November 1987.

14. Soil Survey For Adams County, U. S. Department of Agriculture, Soil Conservation Service, October 1974.

15. Soil Survey for Arapahoe County, U. S. Department of Agriculture, Soil Conservation Service, October 1974.

16. Land Use Definition, TM No 1.1, Denver Regional Council of Governments, Denver, Colorado, January 1987.

17. Northeast Corridor Specific Area Plan, Denver Planning Office, City and County of Denver, Colorado, November 1987.

18. Northeast Corridor Specific Area Plan - Summary, Denver Planning Office, City and County of Denver, Colorado, November 1987.

19. E-470 Preliminary Design Report, Smoky Hill Road to 32nd Ave, Engineer 470 Partnership, May 1987 (2 volumes).

20. Water And Wastewater System Master Plan Update & system Development Fees, South Adams County Water and Sanitation District, James M. Montgomery, Consulting Engineers, Inc., July 1985.

21. Airport Planning Area Water and Wastewater Service Study, South Adams County Water and Sanitation District, Black and Veatch, March 1987.

22. Detention Routing Data from Greiner Engineering Sciences, Inc. for Green Valley Ranch, January 1988.

23. HEC-1 Input Data, U.S. Army Corps of Engineers, Omaha District, Wallace Stern, Chief Hydrology & Meteorology Section, Hydrologic Engineering Branch, January 22, 1988.

24. Water And Drainage At First Creek, Engineering Consultants, Inc., Denver, Colorado, July 1974.

25. "Offer to Sell Easement and to Realign, Reconstruct and Repair Highline Canal Lateral" Agreement between the United States and Nu-West, Inc. A Colorado Corporation, dated December 10, 1982.

26. "Preliminary Hydrology Report Irondale Gulch Basin Aurora Properties Aurora Colorado", Union Pacific Realty Company, Omaha, NE 68131, December 1987

27. "Memorandum of Agreement between the Program Manager for the Rocky Mountain Arsenal Contamination Cleanup and the City and County of Denver", (no date)

28. "Master Drainage Study for Chambers/Tower Property Basin B", Rocky Mountain Consultants, Inc, Engelwood, CO, November 1986, Revised May 1987

29. Plans and Specifications for "Rehabilitation of Lower Derby Dam, Rocky Mountain Arsenal, Colorado", US Army Corps of Engineers, (no date)

30. "Appraisal of Rocky Mountain Arsenal Property, Adams County Colorado", Justin H. Haynes & Co, Denver, CO August 2, 1983.

31. Planning of First Creek, Irondale Gulch and DFA 0055 Outfall Systems, "Hydrology Report", Wright Water Engineers, Inc, Denver, CO, April 1988.

32. "Analysis of Peak Flows from Parkfield Development to Rocky Mountain Arsenal", By Hydro-Triad, Ltd., Lakewood, CO August 9, 1988

DRAWING REFERENCES

1. Airport Planning Map - Property Ownership as of June 1986, Adams County, Aurora, Commerce City, 1" = 4500'.

2. Airport Planning Map - Planned Urbanization Areas, March 1987, Adams County, Aurora, Commerce City 1" = 4500'.

3. First Creek - BAsin and Sub-basin Boundaries, Simons Li & Associates, 1" = 2000'.

4. First Creek - Future Land Use Map, Simons Li & Associates, 1" = 2000'.

5. First Creek - Soil Map, Simons Li & Associates, 1" = 2000'.

6. Brighton Colorado, 1987 Land Use Map, City of Brighton, Colorado, 1" = 1000' (3 sheets).

7. Arsenal Area Aerial Photograph, Colorado Aerial Photo Service, 1" = 2000', flown November 18, 1984.

8. Aerial Photographs of First Creek and Irondale Gulch, Colorado Aerial Photo Service, October 15, 1987, September 30, 1987, and October 1, 1987.

9. Future Land Use Map with Airport, Commerce City, Colorado, 1" = 4000', November 1984.

10. Future Land Use Plan, Adams County Planning Department, Adams County, Colorado, (no date).

11. Zoning Map, Commerce City (3 sheets), 1" = 500',(no date).

12. Zoning 1987, (15 sheets) Adams County Planning Department, Adams County Colorado, 1" = 500'.

13. Green Valley Ranch Historic Drainage Basins, MSM Inc., 1" = 500', January 1982.

14 Quarter Section Map for Storm Drainage, Sections 17, 22, & 23 Township 3 South, Range 66 West, Denver Wastewater Management, City and County of Denver, 1" = 100'.

15. Storm Drainage System Maps, Montbello Area, Drawings E3 & E2, Denver Wastewater Management, City and County of Denver, 1" = 500'.

16. 1987 Zoning Map Denver and Environs Areas, Denver Planning Office, City and County of Denver, Colorado.

17. Plans for the Rehabilitation of Lower Derby Dam, US Army Corps of Engineers, Omaha, NE, dwg code F871-40-01 (no date)

APPENDIX A

COMMENT LETTERS

HOLME ROBERTS & OWEN

ATTORNEYS AT LAW

SUITE 400
102 NORTH CASCADE AVENUE
COLORADO SPRINGS, COLORADO 80903

SUITE 900
50 SOUTH MAIN STREET
SALT LAKE CITY, UTAH 84144

1700 BROADWAY
DENVER, COLORADO 80290
TELEPHONE (303) 861-7000
TELECOPIER 861-4578
TELEX 45-4460

DENVER TECHNOLOGICAL CENTER
SUITE 900
8400 EAST PRENTICE AVENUE
ENGLEWOOD, COLORADO 80111

SUITE 400
1401 PEARL STREET
BOULDER, COLORADO 80302

October 27, 1988

Mr. Ben Urbonas, Chief
Master Planning Program
Urban Drainage and Flood Control District
2480 W. 26th Ave., Suite 156B
Denver, CO 80211

Dear Mr. Urbonas:

Enclosed please find MKE/Shell's comments on the Draft Alternative Report for the planning of First Creek, Irondale Gulch, and DFA 0055 Outfall Systems.

With best regards.

Sincerely yours,

Edgar A. Benton

EAB/mp

Enclosure

cc: (w/enclosure)
Mr. Donald L. Campbell
Office of the Program Manager
Rocky Mountain Arsenal, Bldg. 111
ATTN: AMXRM-PM
Commerce City, CO 80022-2180

Mr. Brian Anderson, Technical Operations Division
Office of the Program Manager for Rocky Mountain Arsenal
ATTN: AMXRM-TO: Mr. B. Anderson
Commerce City, CO 80022-2180

Mr. William P. Ruzzo
Wright Water Engineers, Inc.
2490 West 26th Ave., Suite 55A
Denver, CO 80211

MKE/SHELL COMMENTS ON THE DRAFT ALTERNATIVE REPORT FOR THE PLANNING OF FIRST CREEK, IRONDALE GULCH, AND DFA 0055 OUTFALL SYSTEMS STUDY BY WRIGHT WATER ENGINEERS, INC.

1. Page II-2, C. Soils Description

Why were some soils combined with the predominant adjacent soils? Why not just use a weighted average of all soil types?

2. Page II-11, Reach PRI-6

Why were these tributaries assumed to have separate channels if they are actually combined in one channel discharging into the Uvalda channel at the RMA southern boundary?

3. Page II-12, Table II-1

Basin C was simulated as wet, but it actually is dry.

4. Page IV-2, Detention Areas

U.S.G.S. topographic maps show some small detention facilities in the First Creek Basin. One is located just downstream of the RMA north boundary before the creek joins the O'Brian Canal.

5. Page IV-3, First Creek Floodplain

The assumed overall imperviousness of 48% for the First Creek future development condition seems high considering the current rural and undeveloped nature of the basin. The assumed imperviousness of 95% (map symbol "B") is probably high for any development scenario. In addition, the assumed imperviousness of 80% (map symbol "E") in the South Plants area, North Plants area, and especially in the area east of the South Plants area of the RMA, is probably high.

6. Page IV-3, First Creek Floodplain

What return period (flood) is the floodplain based on?

10/27/88

October 14, 1988

Mr. Ben Urbonas, Chief
Master Planning Program
Urban Drainage and Flood Control District
2480 W. 26th Ave., Suite 156-B
Denver, Colorado 80211

RE: Review of First Creek and Irondale Gulch Outfall Systems Study

Dear Mr. Urbonas:

McLaughlin Water Engineers, Ltd. have reviewed the above-mentioned report on behalf of the First Creek Metropolitan District (FCMD). The following is a summary of the review and our Board of Directors recommendations regarding the report:

1) The FCMD concurs with the recommendations of the study that has Greens Reservoir on the Rocky Mountain Arsenal (RMA) as the most practical and economical alternative.

2) The report should include discussions and cost information that shows specific recommendations for the next best alternative, if the RMA or the Federal Government do not concur with the report. The report currently does not clearly discuss this possibility.

3) Change the name of the "Developers Option" to something else. This name was applied because of a meeting where developers were present. The FCMD do represent some of the developers that would be affected by the so-called developers option and they do not favor this option. The name implies they do, however.

4) If the RMA option of Greens Reservoir were to not materialize, and the next option were to be the two-dam system, could the dam be moved to be within the corridor along the proposed Airport Blvd. This would allow multi-use of the area while maintaining the open space concept.

The FCMD Board of Directors approved the above comments by Board Resolution on October 10, 1988.

We appreciate the opportunity to review this report and make our concerns known. If you need further information, please call.

Very truly yours,

First Creek Metropolitan District

David Berger
Manager

by Brian S. Kobstad
McLaughlin Water Engineers, Ltd.

cc: Bill Ruzzo, Wright Water Engineers ✓

BSK:cn
84-038.00P
1-BSK

United States Department of the Interior
FISH AND WILDLIFE SERVICE
COLORADO FIELD OFFICE
730 SIMMS STREET
ROOM 292
GOLDEN, COLORADO 80401

IN REPLY REFER TO:

September 20, 1988

Mr. William P. Ruzzo, P.E.
Project Manager
Wright Water Engineers, Inc.
2490 West 26th Avenue, Suite 55A
Denver, Colorado 80211

Dear Mr. Ruzzo:

In response to your request of August 22, 1988 we are providing you with a list of federally listed threatened, endangered and candidate species which do or may occur on the Rocky Mountain Arsenal (Arsenal) and the First Creek drainage area in general. The bald eagle (Haliaeetus leucocephalus) is the only currently listed species which is known to occur on the Arsenal. Several listed species whose presence has not been documented, but which may occur occasionally in the area include:

peregrine falcon	Falco peregrinus	E
whooping crane	Grus americana	E

Surveys for black-footed ferrets (Mustela nigripes) have concluded that this species is not now present on Arsenal lands. No further surveys for ferrets will be required unless new information regarding the potential for occurrence is obtained.

These survey results do not apply to areas outside Arsenal boundaries however. The First Creek corridor should be surveyed for the presence of prairie dog colonies prior to construction, and preferably before selection of a final channel design. The Service will provide survey methodology guidelines in the near future for your information.

The study area also supports numerous species of raptors including Swainson's hawk (Buteo swainsoni) and ferruginous hawks (Buteo regalis), both candidates for federal listing. The Arsenal periodically harbors a significant concentration of these and other raptors. Protection and maintenance of foraging and roosting habitat to the greatest extent possible is of great concern to the Service.

In addition to our responsibilities under the Endangered Species Act, the Service is also charged with duties under the Fish and Wildlife Coordination Act (Coordination Act) and Executive Order No. 11990-Protection of Wetlands. The Coordination Act requires that Federal agencies planning, funding, or permitting water development projects contact the Service and State wildlife agency for their views and recommendations. The Executive Order requires Federal agencies to review their actions to insure that impacts to wetlands are avoided to the greatest extent possible. It is under these two directives that the Service will eventually be asked to review and comment upon the potential impacts of the First Creek project to non-threatened and endangered species and habitats. Our primary concerns in this regard are now focused on the Arsenal due to the high value and density of wildlife which occurs there.

We wish to work closely with Wright Water Engineers and Urban Drainage to insure that impacts to wildlife, particularly bald eagles and other raptors, are avoided to the maximum degree and that effective mitigation is designed and implemented for all unavoidable impacts. From the preliminary information developed for the First Creek project it appears that integration of wildlife values with drainage concerns will be possible. Although the Arsenal will be the focus of Service efforts, wetlands and riparian habitats throughout the First Creek drainage will also be of concern. We look forward to working with you and Urban Drainage on those issues as well. For further information please contact Bill Noonan of my staff at 236-2675.

Sincerely,

LeRoy W. Carlson
Acting State Supervisor

cc: FWE/Golden (Attn:Pete Gober)
CDOW/Denver (Attn: Dave Weber)
EPA/Denver (Attn: Brad Miller)
RMA/Denver (Attn:
File
Reading File

APPENDIX B

EVALUATION MATRIX

FIRST CREEK, IRONDALE GULCH AND DFA 0055
OUTFALL SYSTEMS PLANNING STUDY
EVALUATION MATRIX

FILE:\ARSNL\879IRTE.WK1 IRONDALE GULCH PLAN NO 1 (W/O MINI-REGIONAL DETENTION) 28-Aug-88

			ENGINEERING CONSIDERATIONS										ENVIRONMENTAL AND AESTHETIC CONSIDERATIONS										
PLANNING REACH	JURISDICT	RATING	EROSION SEDIMENT.	PROPRTY FLDING	TRANSPORT. FLDING	CONSTRUCT-ABILITY	COST	ADMINIS.	MINIMAL MAINTEN	MINIMUM ROW REQ	SUB-TOTAL	RELATIVE RATING	STREAM INTACT	WILD HABITAT	VEGET.	DEVEL. TYPE	VISIB./ PROX.	O. SPACE RECREA.	RMA CLEANUP	SUB-TOTAL	RELATIVE RATING	GRAND TOTALS
NO 1	COMMERCE CITY	Rel. Import.	1	8	7	6	5	4	3	2		80	2	3	4	5	6	7	1		20	117
		Rating	1	3	3	4	5	4	3	3			1	1	1	3	3	3	1			
		Comb. Rtng.	1	24	21	24	25	16	9	6	126		2	3	4	15	18	21	1	64		
NO 2	ARSENAL	Rel. Import.	8	3	7	2	5	4	6	1		40	3	5	4	1	2	6	7		60	91
		Rating	3	1	3	4	5	2	3	4			1	2	1	1	2	3	3			
		Comb. Rtng.	24	3	21	8	25	8	18	4	111		3	10	4	1	4	18	21	61		
NO 3	ARSENAL	Rel. Import.	7	8	3	5	6	2	4	1		60	6	4	5	1	2	3	7		40	90
		Rating	4	1	3	4	5	3	2	4			1	1	1	1	2	1	3			
		Comb. Rtng.	28	8	9	20	30	6	8	4	113		6	4	5	1	4	3	21	44		
NO 4	ARSENAL	Rel. Import.	8	4	6	5	7	2	3	1		10	2	3	4	5	6	1	7		90	97
		Rating	3	1	3	5	5	5	3	4			3	3	3	2	2	3	3			
		Comb. Rtng.	24	4	18	25	35	10	9	4	129		6	9	12	10	12	3	21	73		
NO 5	ARSENAL	Rel. Import.	8	7	6	4	5	2	3	1		70	1	2	3	5	6	4	7		30	112
		Rating	4	2	3	4	5	1	2	4			1	3	2	3	2	4	3			
		Comb. Rtng.	32	14	18	16	25	2	6	4	117		1	6	6	15	12	16	21	77		
NO 6	ARSENAL	Rel. Import.	8	7	6	4	5	2	3	1		50	6	4	5	1	2	3	7		50	92
		Rating	3	1	3	4	5	1	3	4			2	2	2	2	1	2	3			
		Comb. Rtng.	24	7	18	16	25	2	9	4	105		12	8	10	2	2	6	21	61		
NO 7	DENVER/AURORA	Rel. Import.	1	8	7	4	6	3	2	5		40	2	3	4	5	6	7	1		60	132
		Rating	4	4	4	4	5	3	4	4			4	3	3	4	4	3	1			
		Comb. Rtng.	4	32	28	16	30	9	8	20	147		8	9	12	20	24	21	1	95		
	TOTALS		137	92	133	125	195	53	67	46	848		38	49	53	64	76	88	107	475		732

FIRST CREEK, IRONDALE GULCH AND DFA 0055
OUTFALL SYSTEMS PLANNING STUDY
EVALUATION MATRIX

FILE:\ARSNL\B791RTE.WK1 IRONDALE GULCH PLAN NO 2 (W/O MINI-REGIONAL DETENTION) 28-Aug-88

			ENGINEERING CONSIDERATIONS										ENVIRONMENTAL AND AESTHETIC CONSIDERATIONS										
PLANNING REACH	JURISDICT	RATING	EROSION SEDIMENT.	PROPRTY FLDING	TRANSPORT. FLDING	CONSTRUCT-ABILITY	COST	ADMINIS.	MINIMAL MAINTEN	MINIMUM ROW REQ	SUB-TOTAL	RELATIVE RATING	STREAM INTACT	WILD HABITAT	VEGET.	DEVEL. TYPE	VISIB./ PROX.	O. SPACE RECREA.	RMA CLEANUP	SUB-TOTAL	RELATIVE RATING	GRAND TOTALS
NO 1	COMMERCE CITY	*Rel. Import.*	1	8	7	6	5	4	3	2 *		80 **	2	3	4	5	6	7	1 *	*	20 **	110 **
		*Rating *	1	3	3	4	3.1	4	3	3 *		**	1	1	1	3	3	3	1 *	*	**	**
		*Comb. Rtng. *	1	24	21	24	15.5	16	9	6 *	116.5	**	2	3	4	15	18	21	1 *	64 *	**	**
		* *								*		**							*	*	**	**
NO 2	ARSENAL	*Rel. Import.*	8	3	7	2	5	4	6	1 *		40 **	3	5	4	1	2	6	7 *	*	60 **	88 **
		*Rating *	3	1	3	4	3.1	2	3	4 *		**	1	2	1	1	2	3	3 *	*	**	**
		*Comb. Rtng. *	24	3	21	8	15.5	8	18	4 *	101.5	**	3	10	4	1	4	18	21 *	61 *	**	**
		* *								*		**							*	*	**	**
NO 3	ARSENAL	*Rel. Import.*	7	8	3	5	6	2	4	1 *		60 **	6	4	5	1	2	3	7 *	*	40 **	87 **
		*Rating *	5	1	3	4	3.1	2	2	4 *		**	1	1	1	1	2	1	3 *	*	**	**
		*Comb. Rtng. *	35	8	9	20	18.6	4	8	4 *	106.6	**	6	4	5	1	4	3	21 *	44 *	**	**
		* *								*		**							*	*	**	**
NO 4	ARSENAL	*Rel. Import.*	8	4	5	1	3	2	7	6 *		10 **	2	3	4	5	6	1	7 *	*	90 **	96 **
		*Rating *	3	1	3	5	3.1	5	3	4 *		**	3	3	3	2	2	3	3 *	*	**	**
		*Comb. Rtng. *	24	4	15	5	9.3	10	21	24 *	112.3	**	6	9	12	10	12	3	21 *	73 *	**	**
		* *								*		**							*	*	**	**
NO 5	ARSENAL	*Rel. Import.*	8	7	6	4	5	2	3	1 *		70 **	1	2	3	5	6	4	7 *	*	30 **	107 **
		*Rating *	5	1	3	4	3.1	1	3	3 *		**	1	3	2	3	2	4	3 *	*	**	**
		*Comb. Rtng. *	40	7	18	16	15.5	2	9	3 *	110.5	**	1	6	6	15	12	16	21 *	77 *	**	**
		* *								*		**							*	*	**	**
NO 6	ARSENAL	*Rel. Import.*	8	7	6	4	5	2	3	1 *		50 **	6	4	5	1	2	3	7 *	*	50 **	101 **
		*Rating *	3	1	3	4	3.1	1	3	4 *		**	3	3	3	2	3	3	3 *	*	**	**
		*Comb. Rtng. *	24	7	18	16	15.5	2	9	4 *	95.5	**	18	12	15	2	6	9	21 *	83 *	**	**
		* *								*		**							*	*	**	**
NO 7	DENVER/AURORA	*Rel. Import.*	1	8	7	4	6	3	2	5 *		40 **	2	3	4	5	6	7	1 *	*	60 **	128 **
		*Rating *	4	4	4	4	3.1	3	4	4 *		**	4	3	3	4	4	3	1 *	*	**	**
		*Comb. Rtng. *	4	32	28	16	18.6	9	8	20 *	135.6	**	8	9	12	20	24	21	1 *	95 *	**	**
	TOTALS		152	85	130	105	109	51	82	65	779		44	53	58	64	80	91	107	497	**********	**********
																					**	715 **
																					**********	

FIRST CREEK, IRONDALE GULCH AND DFA 0055
OUTFALL SYSTEMS PLANNING STUDY
EVALUATION MATRIX

FILE:\ARSNL\8791RTE.WK1 IRONDALE GULCH PLAN NO 3 (W/O MINI-REGIONAL DETENTION) 28-Aug-88

			ENGINEERING CONSIDERATIONS										ENVIRONMENTAL AND AESTHETIC CONSIDERATIONS										
PLANNING REACH	JURISDICT	RATING	EROSION SEDIMENT.	PROPRTY FLDING	TRANSPORT. FLDING	SEGMENT CONSTRUCT	COST	FINANCIN	MINIMAL MAINTEN	MINIMUM ROW REQ	SUB-TOTAL	RELATIVE RATING	STREAM INTACT	WILD HABITAT	VEGET.	DEVEL. TYPE	VISIB./ PROX.	O. SPACE RECREA.	RMA CLEANUP	SUB-TOTAL	RELATIVE RATING	GRAND TOTALS
NO 1	COMMERCE CITY	Rel. Import.	1	8	7	6	5	4	3	2		80	2	3	4	5	6	7	1		20	108
		Rating	1	3	3	4	2.7	4	3	3			1	1	1	3	3	3	1			
		Comb. Rtng.	1	24	21	24	13.5	16	9	6	114.5		2	3	4	15	18	21	1	64		
NO 2	ARSENAL	Rel. Import.	8	3	7	2	5	4	6	1		40	3	5	4	1	2	6	7		60	88
		Rating	3	1	3	4	2.7	3	3	4			1	2	1	1	2	3	3			
		Comb. Rtng.	24	3	21	8	13.5	12	18	4	103.5		3	10	4	1	4	18	21	61		
NO 3	ARSENAL	Rel. Import.	7	8	3	5	6	2	4	1		60	6	4	5	1	2	3	7		40	86
		Rating	5	1	3	4	2.7	3	2	4			1	1	1	1	2	1	3			
		Comb. Rtng.	35	8	9	20	16.2	6	8	4	106.2		6	4	5	1	4	3	21	44		
NO 4	ARSENAL	Rel. Import.	8	4	5	1	3	2	7	6		10	2	3	4	5	6	1	7		90	96
		Rating	3	1	3	5	2.7	5	3	4			3	3	3	2	2	3	3			
		Comb. Rtng.	24	4	15	5	8.1	10	21	24	111.1		6	9	12	10	12	3	21	73		
NO 5	ARSENAL	Rel. Import.	8	7	6	4	5	2	3	1		70	1	2	3	5	6	4	7		30	87
		Rating	2	1	3	1	2.7	4	3	1			1	3	2	4	3	4	3			
		Comb. Rtng.	16	7	18	4	13.5	8	9	1	76.5		1	6	6	20	18	16	21	88		
NO 6	ARSENAL	Rel. Import.	8	7	6	4	5	2	3	1		50	6	4	5	1	2	3	7		50	86
		Rating	3	1	3	4	2.7	1	3	4			2	2	2	1	2	2	3			
		Comb. Rtng.	24	7	18	16	13.5	2	9	4	93.5		12	8	10	2	2	6	21	61		
NO 7	DENVER/AURORA	Rel. Import.	1	8	7	4	6	3	2	5		40	2	3	4	5	6	7	1		60	125
		Rating	4	4	4	4	2.7	2	4	4			4	3	3	4	4	3	1			
		Comb. Rtng.	4	32	28	16	16.2	6	8	20	130.2		8	9	12	20	24	21	1	95		
	TOTALS		128	85	130	93	95	60	82	63	736		38	49	53	69	82	88	107	486		677

FIRST CREEK, IRONDALE GULCH AND DFA 0055
OUTFALL SYSTEMS PLANNING STUDY
EVALUATION MATRIX

FILE:\ARSNL\8791RTE.WK1 IRONDALE GULCH PLAN NO 4 (W/O MINI-REGIONAL DETENTION) 28-Aug-88

			ENGINEERING CONSIDERATIONS										ENVIRONMENTAL AND AESTHETIC CONSIDERATIONS										
PLANNING REACH	JURISDICT	RATING	EROSION SEDIMENT.	PROPRTY FLDING	TRANSPORT. FLDING	SEGMENT CONSTRUCT	COST	FINANCIN	MINIMAL MAINTEN	MINIMUM ROW REQ	SUB-TOTAL	RELATIVE RATING	STREAM INTACT	WILD HABITAT	VEGET.	DEVEL. TYPE	VISIB./ PROX.	O. SPACE RECREA.	RMA CLEANUP	SUB-TOTAL	RELATIVE RATING	GRAND TOTALS
NO 1	COMMERCE CITY	Rel. Import.	1	8	7	6	5	4	3	2		80	2	3	4	5	6	7	1		20	101
		Rating	1	3	3	4	1	4	3	3			1	1	1	3	3	3	1			
		Comb. Rtng.	1	24	21	24	5	16	9	6	106		2	3	4	15	18	21	1	64		
NO 2	ARSENAL	Rel. Import.	8	3	7	2	5	4	6	1		40	3	5	4	1	2	6	7		60	85
		Rating	3	1	3	4	1	3	3	4			1	2	1	1	2	3	3			
		Comb. Rtng.	24	3	21	8	5	12	18	4	95		3	10	4	1	4	18	21	61		
NO 3	ARSENAL	Rel. Import.	7	8	3	5	6	2	4	1		60	6	4	5	1	2	3	7		40	80
		Rating	5	1	3	4	1	3	2	4			1	1	1	1	2	1	3			
		Comb. Rtng.	35	8	9	20	6	6	8	4	96		6	4	5	1	4	3	21	44		
NO 4	ARSENAL	Rel. Import.	8	4	5	1	3	2	7	6		10	2	3	4	5	6	1	7		90	95
		Rating	3	1	3	4	1	5	3	4			3	3	3	2	2	3	3			
		Comb. Rtng.	24	4	15	4	3	10	21	24	105		6	9	12	10	12	3	21	73		
NO 5	ARSENAL	Rel. Import.	8	7	6	4	5	2	3	1		70	1	2	3	5	6	4	7		30	98
		Rating	4	3	3	1	1	1	3	1			1	3	2	4	3	4	3			
		Comb. Rtng.	32	21	18	4	5	2	9	1	92		1	6	6	20	18	16	21	88		
NO 6	ARSENAL	Rel. Import.	8	7	6	4	5	2	3	1		50	6	4	5	1	2	3	7		50	88
		Rating	4	3	3	1	1	1	3	1			2	2	2	3	3	2	3			
		Comb. Rtng.	32	21	18	4	5	2	9	1	92		12	8	10	3	6	6	21	66		
NO 7	DENVER/AURORA	Rel. Import.	1	8	7	4	6	3	2	5		40	2	3	4	5	6	7	1		60	121
		Rating	4	4	4	4	1	2	4	4			4	3	3	4	4	3	1			
		Comb. Rtng.	4	32	28	16	6	6	8	20	120		8	9	12	20	24	21	1	95		
	TOTALS		152	113	130	80	35	54	82	60	706		38	49	53	70	86	88	107	491		670

FIRST CREEK, IRONDALE GULCH AND DFA 0055
OUTFALL SYSTEMS PLANNING STUDY
EVALUATION MATRIX

FILE:\ARSNL\FIRSTEVAL.WK1 FIRST CREEK CHANNEL SELECTION EVALUATION 12-Nov-88

				ENGINEERING CONSIDERATIONS									ENVIRONMENTAL AND AESTHETIC CONSIDERATIONS									
PLANNING REACH	JURISDICT	CHANNEL OPTION	RATING	EROSION SEDIMENT.	PROPRTY FLDING	CONSTRCT-ABILITY	COST	ADMIN & IMPLEM.	MINIMAL MAINTEN	MINIMUM ROW REQ	SUB-TOTAL	RELATIVE RATING	STRM INT.	WILD HAB.	VEG.	DEV. TYPE	VIS./ PROX.	OS/ REC'N	RMA CLEANUP	SUB-TOTAL	RELATIVE RATING	GRAND TOTALS
NO 1	COMMERCE CITY		Rel. Import.	6	1	7	5	3	4	2		60	2	3	4	5	6	7	1		40	
		ENG FLDWY	Rating	2	2	4	5	3	2	4			2	2	3	3	1	2	1			
			Comb. Rtng.	12	2	28	25	9	8	8	92		4	6	12	15	6	14	1	58		78
		ENG WTLND	Rating	3	2	3	3.8	2	2	3			2	3	4	3	4	4	1			
			Comb. Rtng.	18	2	21	19	6	8	6	80		4	9	16	15	24	28	1	97		87
		OPEN SPC	Rating	4	1	2	1	3	1	2			2	5	5	4	5	5	1			
			Comb. Rtng.	24	1	14	5	9	4	4	61		4	15	20	20	30	35	1	125		87
NO 2	COMMERCE CITY		Rel. Import.	5	3	7	4	6	1	2		70	2	3	4	5	6	7	1		30	
		ENG FLDWY	Rating	3	3	4	5	2	3	3			2	2	2	3	1	2	1			
			Comb. Rtng.	15	9	28	20	12	3	6	93		4	6	8	15	6	14	1	54		81
		ENG WTLND	Rating	3	2	3	4.9	2	2	3			2	3	3	3	4	3	1			
			Comb. Rtng.	15	6	21	19.6	12	2	6	82		4	9	12	15	24	21	1	86		83
		OPEN SPC	Rating	4	1	1	1	3	1	1			2	4	3	4	4	4	1			
			Comb. Rtng.	20	3	7	4	18	1	2	55		4	12	12	20	24	28	1	101		69
NO 3	COMMERCE CITY		Rel. Import.	7	4	6	5	1	3	2		30	7	5	6	2	3	4	1		70	
		ENG FLDWY	Rating	3	4	4	5	4	3	3			1	1	1	3	1	2	1			
			Comb. Rtng.	21	16	24	25	4	9	6	105		7	5	6	6	3	8	1	36		57
		ENG WTLND	Rating	3	3	3	4.6	4	2	3			1	1	1	3	3	3	1			
			Comb. Rtng.	21	12	18	23	4	6	6	90		7	5	6	6	9	12	1	46		59
		OPEN SPC	Rating	4	2	2	1	4	1	2			5	3	5	3	4	5	1			
			Comb. Rtng.	28	8	12	5	4	3	4	64		35	15	30	6	12	20	1	119		103
NO 4	ARSENAL		Rel. Import.	7	3	4	6	2	5	1		50	6	4	5	1	2	3	7		50	
		ENG FLDWY	Rating	3	4	4	5	3	3	4			1	1	1	2	1	1	1			
			Comb. Rtng.	21	12	16	30	6	15	4	104		6	4	5	2	2	3	7	29		67
		ENG WTLND	Rating	3	3	3	3.7	3	2	4			1	1	1	2	3	3	1			
			Comb. Rtng.	21	9	12	22.2	6	10	4	84		6	4	5	2	6	9	7	39		62
		OPEN SPC	Rating	4	2	3	1	2	1	3			1	1	1	2	3	4	1			
			Comb. Rtng.	28	6	12	6	4	5	3	64		6	4	5	2	6	12	7	42		53

FIRST CREEK, IRONDALE GULCH AND DFA 0055
OUTFALL SYSTEMS PLANNING STUDY
EVALUATION MATRIX

FILE:\ARSNL\FIRSTEVAL.WK1 — FIRST CREEK — CHANNEL SELECTION EVALUATION — 12-Nov-88

PLANNING REACH	JURISDICT	CHANNEL OPTION	RATING	EROSION/SEDIMENT.	PROPRTY FLDING	CONSTRCT-ABILITY	COST	ADMIN & IMPLEM.	MINIMAL MAINTEN	MINIMUM ROW REQ	SUB-TOTAL	RELATIVE RATING	STRM INT.	WILD HAB.	VEG.	DEV. TYPE	VIS./PROX.	OS/REC'N	RMA CLEANUP	SUB-TOTAL	RELATIVE RATING	GRAND TOTALS
				ENGINEERING CONSIDERATIONS									ENVIRONMENTAL AND AESTHETIC CONSIDERATIONS									
NO 5	ARSENAL		Rel. Import.	7	2	4	6	5	3	1		60	6	4	5	1	3	2	7		40	
		ENG FLDWY	Rating	3	4	4	5	3	3	4			1	1	1	2	2	1	1			
			Comb. Rtng.	21	8	16	30	15	9	4	103		6	4	5	2	6	2	7	32		75
		ENG WTLND	Rating	3	3	3	3.5	3	2	4			1	1	1	2	3	2	1			
			Comb. Rtng.	21	6	12	21	15	6	4	85		6	4	5	2	9	4	7	37		66
		OPEN SPC	Rating	4	2	3	1	2	1	3			3	4	4	2	4	4	1			
			Comb. Rtng.	28	4	12	6	10	3	3	66		18	16	20	2	12	8	7	83		73
NO 6	FIRST CR RNCH		Rel. Import.	4	7	6	5	3	1	2		60	7	5	6	2	3	4	1		40	
		ENG FLDWY	Rating	3	4	4	5	3	3	3			1	1	1	2	1	2	1			
			Comb. Rtng.	12	28	24	25	9	3	6	107		7	5	6	4	3	8	1	34		78
		ENG WTLND	Rating	3	3	3	3.1	2	2	3			1	1	1	2	3	2	1			
			Comb. Rtng.	12	3	21	15.5	6	8	6	72		7	5	6	4	9	8	1	40		59
		OPEN SPC	Rating	4	2	3	1	2	1	2			4	4	4	3	4	4	1			
			Comb. Rtng.	16	2	21	5	6	4	4	58		28	20	24	6	12	16	1	107		78
NO 7	FIRST CR RNCH		Rel. Import.	6	7	5	4	3	2	1		30	7	5	6	2	3	4	1		70	
		ENG FLDWY	Rating	3	3	3	4.4	3	3	4			1	1	1	2	2	3	1			
			Comb. Rtng.	18	21	15	17.6	9	6	4	91		7	5	6	4	6	12	1	41		56
		ENG WTLND	Rating	3	3	3	1	2	2	3			1	1	1	3	3	3	1			
			Comb. Rtng.	18	21	15	4	6	4	3	71		7	5	6	6	9	12	1	46		54
		OPEN SPC	Rating	4	2	2	5	2	1	2			4	4	4	4	5	4	1			
			Comb. Rtng.	24	14	10	20	6	2	2	78		28	20	24	8	15	16	1	112		102

FIRST CREEK, IRONDALE GULCH AND DFA 0055
OUTFALL SYSTEMS PLANNING STUDY
EVALUATION MATRIX

FILE:\ARSNL\FIRSTEVAL.WK1 — FIRST CREEK — CHANNEL SELECTION EVALUATION — 12-Nov-88

PLANNING REACH	JURISDICT	CHANNEL OPTION	RATING	ENGINEERING CONSIDERATIONS: EROSION/SEDIMENT.	PROPRTY FLDING	CONSTRCT-ABILITY	COST	ADMIN & IMPLEM.	MINIMAL MAINTEN	MINIMUM ROW REQ	SUB-TOTAL	RELATIVE RATING	ENVIRONMENTAL AND AESTHETIC CONSIDERATIONS: STRM INT.	WILD HAB.	VEG.	DEV. TYPE	VIS./PROX.	OS/REC'N	RMA CLEANUP	SUB-TOTAL	RELATIVE RATING	GRAND TOTALS
NO 9	GREEN VL RNCH		Rel. Import.	6	7	5	4	3	2	1		30	7	5	6	2	3	4	1		70	
		ENG FLDWY	Rating	3	4	4	1.9	3	3	4			1	1	1	2	1	2	1			
			Comb. Rtng.	18	28	20	7.6	9	6	4	93		7	5	6	4	3	8	1	34		52
		ENG WTLND	Rating	3	3	3	1	2	2	3			1	1	1	3	3	3	1			
			Comb. Rtng.	18	21	15	4	6	4	3	71		7	5	6	6	9	12	1	46		54
		OPEN SPC	Rating	4	2	2	5	2	1	2			4	4	4	4	5	4	1			
			Comb. Rtng.	24	14	10	20	6	2	2	78		28	20	24	8	15	16	1	112		102
	TOTALS	ENG FLDWY		138	124	171	180.2	73	59	42	787		48	40	54	52	35	69	20	318		543
		ENG WTLND		144	80	135	128.3	61	48	38	634		48	46	62	56	99	106	20	437		522
		OPEN SPC		192	52	98	71	63	24	24	524		151	122	159	72	126	151	20	801		665

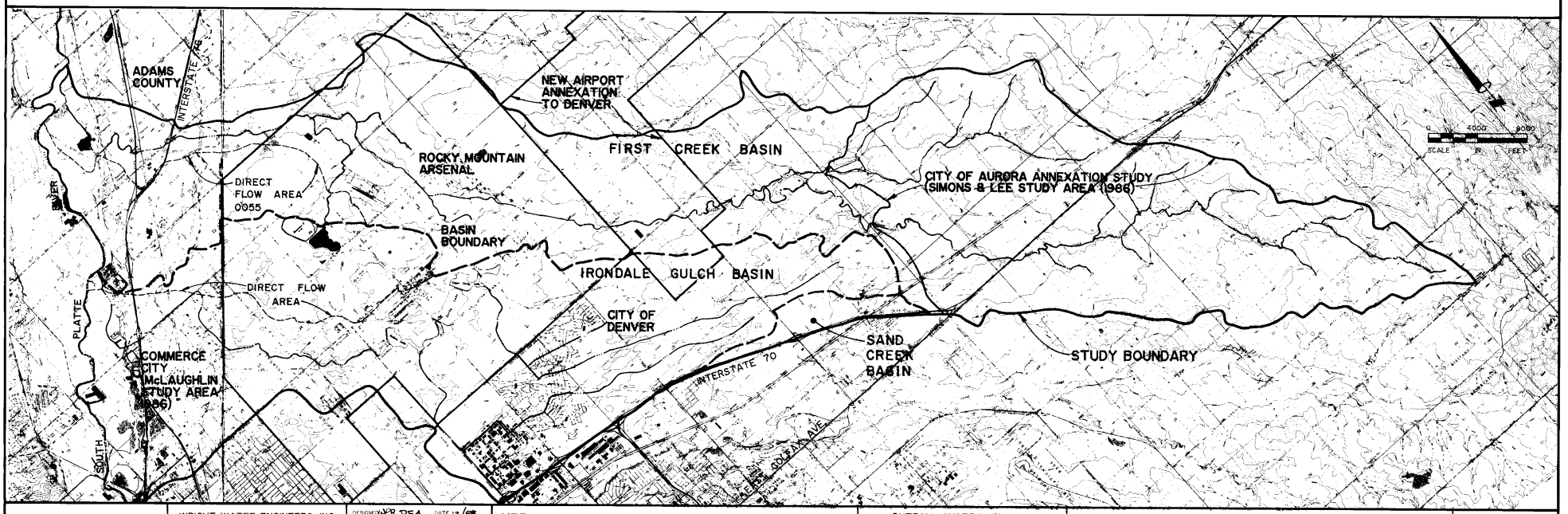
DRAWINGS

FIRST CREEK, IRONDALE GULCH AND DFA0055

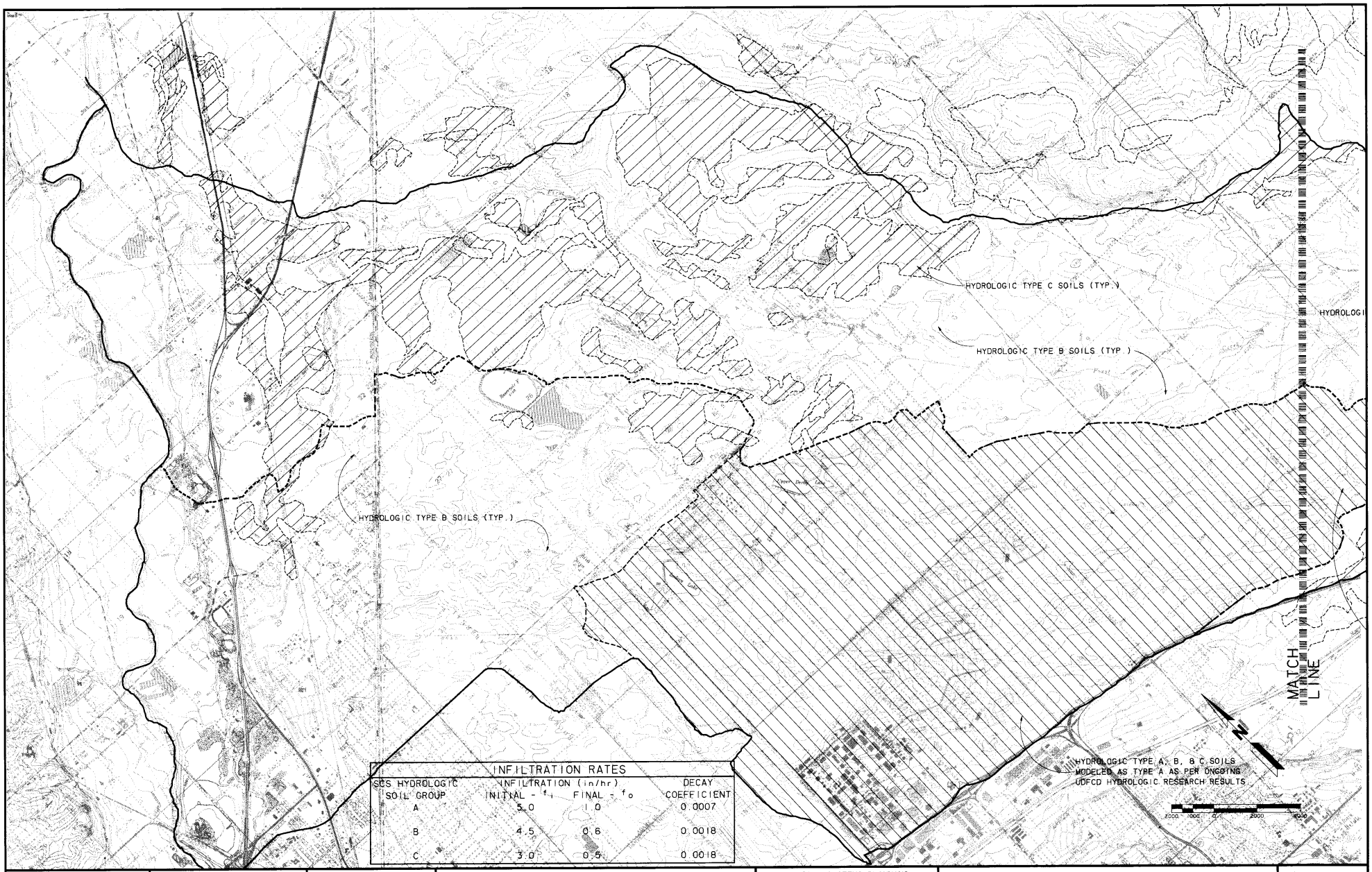
OUTFALL SYSTEM STUDY

ALTERNATIVE REPORT

PROJECT LOCATION AND AREA MAP



BASE MAPS-U.S.G.S. QUADRANGLE SHEETS; BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS	WRIGHT WATER ENGINEERS, INC. 2490 WEST 26th AVE. - SUITE 55A DENVER, COLORADO 80211 (303) 480-1700	DESIGNED JCR, DEA DATE 12/88 DRAWN MVN DATE 12/88 CHECKED DEA DATE 12/88 REVISED DATE	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT ADAMS COUNTY, CITY AND COUNTY OF DENVER CITIES OF AURORA, BRIGHTON AND COMMERCE CITY	OUTFALL SYSTEMS PLANNING FIRST CREEK, IRONDALE GULCH, AND DFA 0055	PROJECT LOCATION AND AREA MAP	DRAWING 1 OF 15



INFILTRATION RATES

SCS HYDROLOGIC SOIL GROUP	INFILTRATION (in/hr) INITIAL - f_i	FINAL - f_o	DECAY COEFFICIENT
A	5.0	1.0	0.0007
B	4.5	0.6	0.0018
C	3.0	0.5	0.0018

BASE MAPS - U.S.G.S. QUADRANGLE SHEETS: BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS

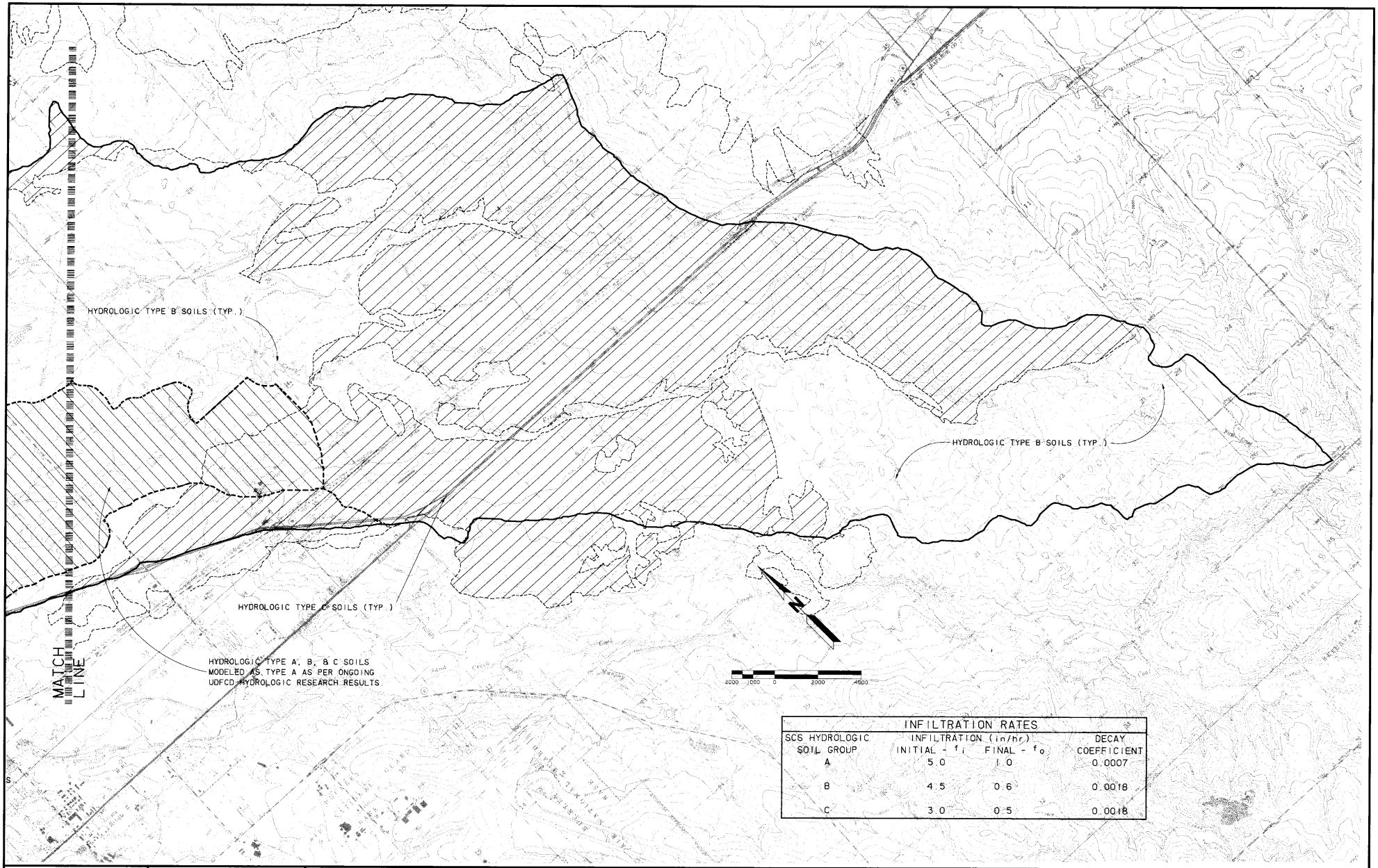
WRIGHT WATER ENGINEERS, INC.
2490 WEST 26th AVE. - SUITE 55A
DENVER, COLORADO 80211
(303) 480-1700

DESIGNED _____ DATE _____
DRAWN _____ DATE _____
CHECKED _____ DATE _____
REVISED _____ DATE _____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER, CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

HYDROLOGIC SOIL TYPES



INFILTRATION RATES			
SCS HYDROLOGIC SOIL GROUP	INFILTRATION (in/hr) INITIAL - f_i	FINAL - f_o	DECAY COEFFICIENT
A	5.0	1.0	0.0007
B	4.5	0.6	0.0018
C	3.0	0.5	0.0018

BASE MAPS - U.S.G.S. QUADRANGLE SHEETS: BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS

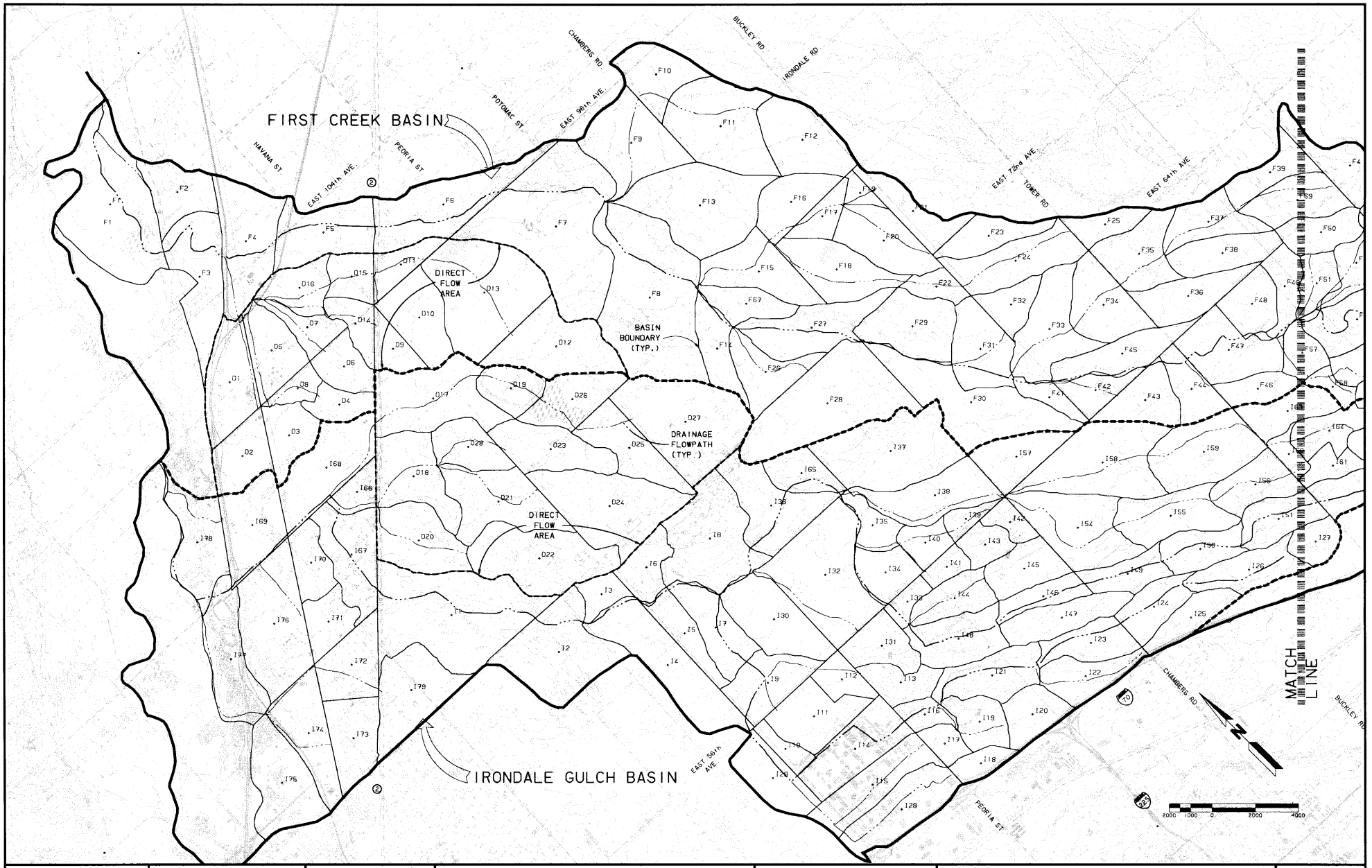
WRIGHT WATER ENGINEERS, INC.
2490 WEST 26th AVE. - SUITE 5SA
DENVER, COLORADO 80211
(303) 480-1700

DESIGNED _____ DATE _____
DRAWN _____ DATE _____
CHECKED _____ DATE _____
REVISED _____ DATE _____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

HYDROLOGIC SOIL TYPES



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DENVER, COLORADO 80211
(303) 480-1700

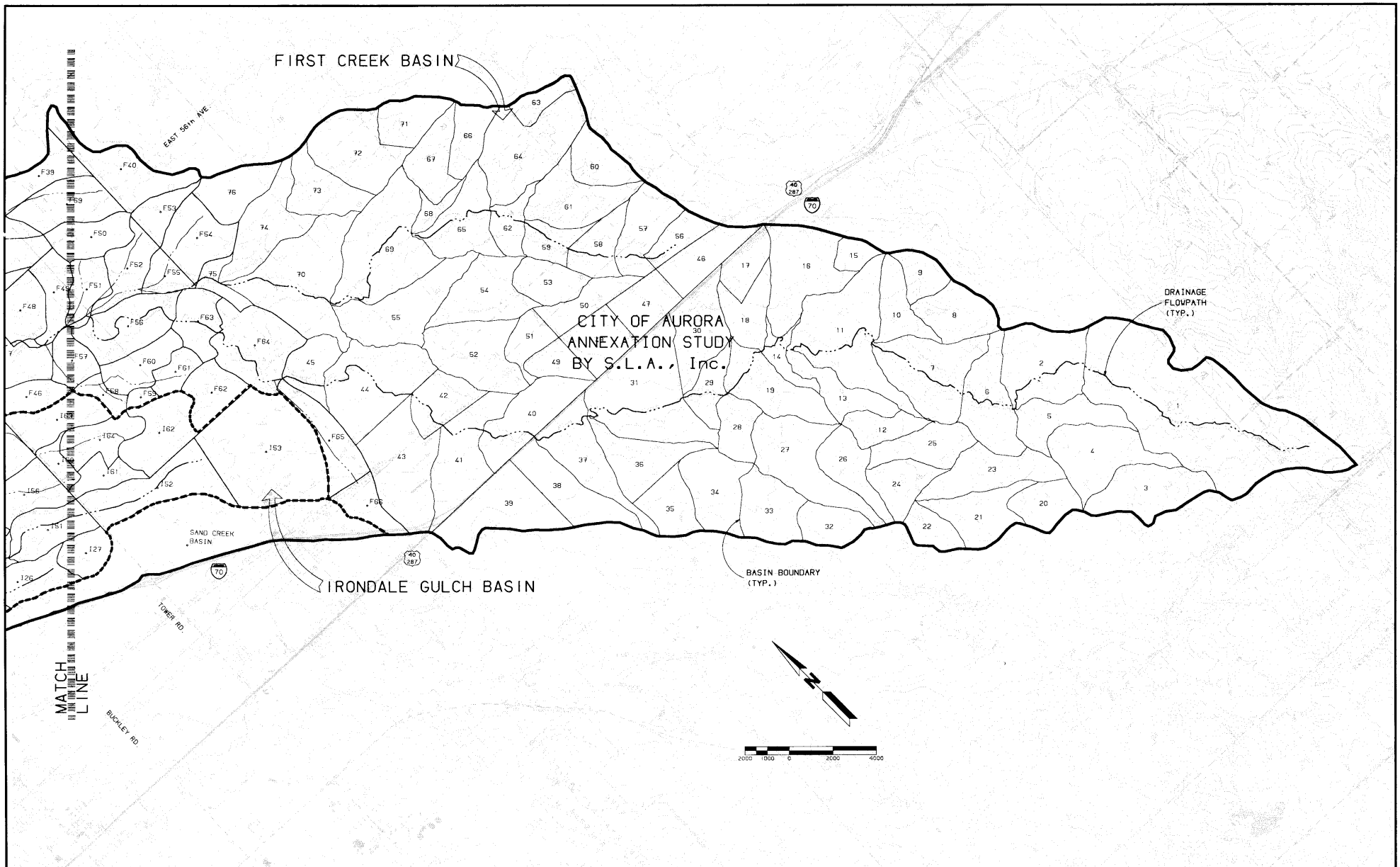
DESIGNED UPR/DFA DATE 12/98
DRAWN MVN DATE 12/98
CHECKED DSR DATE 12/98
REVISED _____ DATE _____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

SUB-BASIN MAP

SHEET 3A OF 15



BASE MAPS - U.S.G.S. QUADRANGLE SHEETS: BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS

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(303) 480-1700

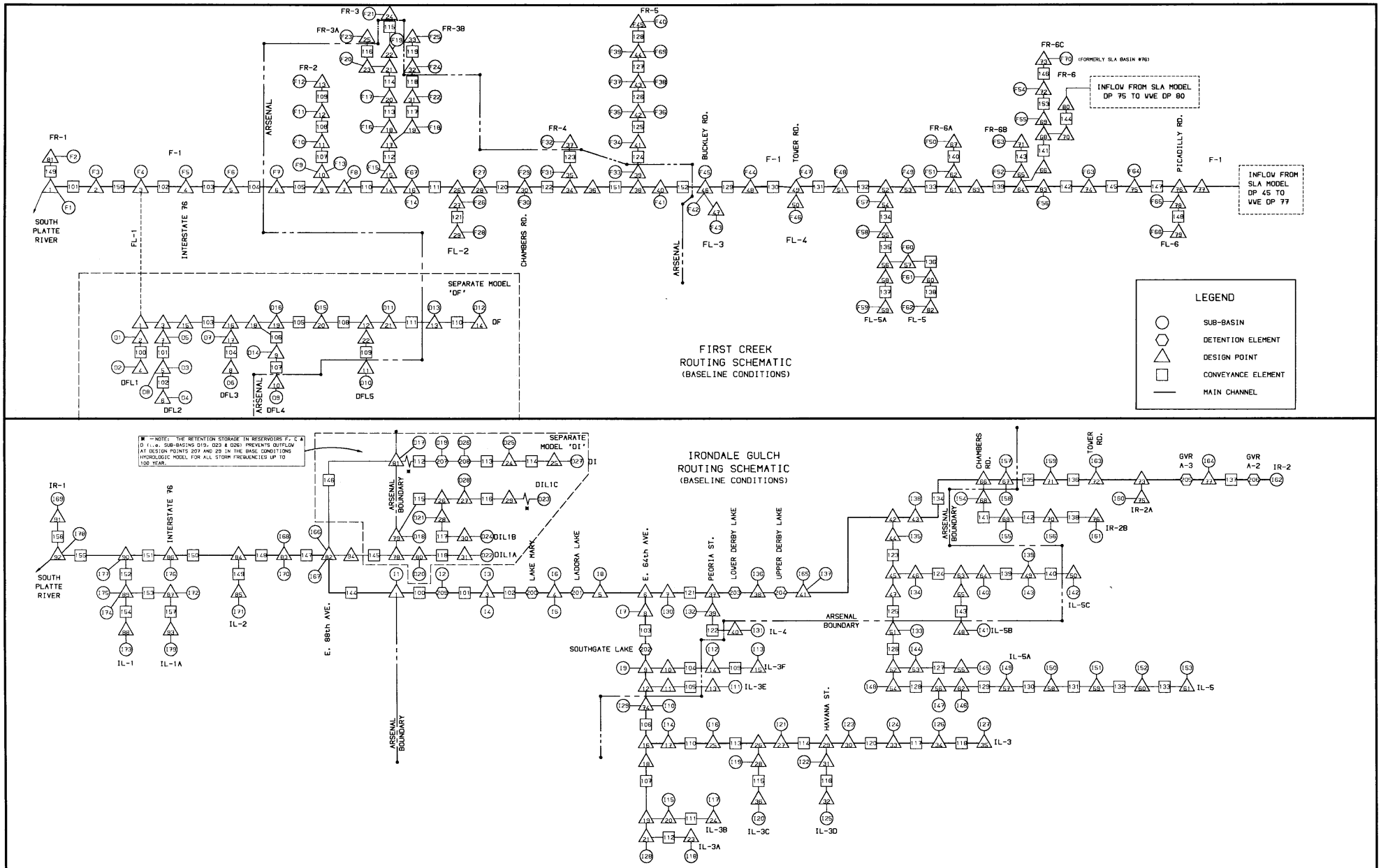
DESIGNED	WRD,DEA	DATE 12/88
DRAWN	MVN	DATE 12/88
CHECKED	WRD	DATE 12/88
REVISED		DATE

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

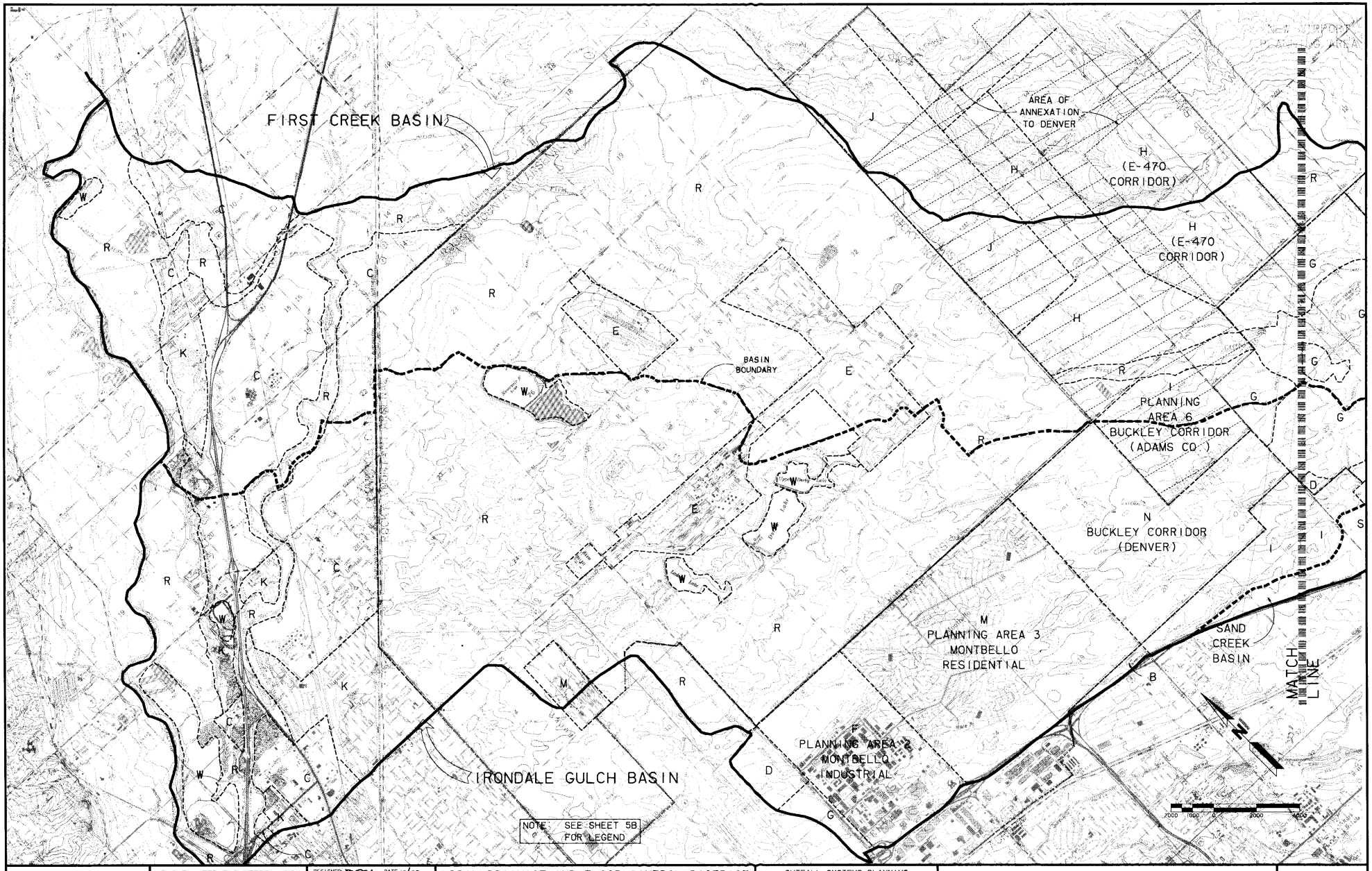
OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH,
AND DFA 0055

SUB-BASIN MAP

SHEET
3B OF 15



BASE MAPS - U.S.G.S. QUADRANGLE SHEETS: BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS	WRIGHT WATER ENGINEERS, INC. 2490 WEST 26th AVE. - SUITE 100A DENVER, COLORADO 80211 (303) 480-1700	DESIGNED PRDEA DATE 12/88 DRAWN KVN DATE 12/88 CHECKED DATE 12/88 REVISED DATE	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT ADAMS COUNTY, CITY AND COUNTY OF DENVER, CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY	OUTFALL SYSTEMS PLANNING FIRST CREEK, IRONDALE GULCH, AND DFA 0055	SWMM ROUTING SCHEMATIC DIAGRAM	SHEET 4 OF 15



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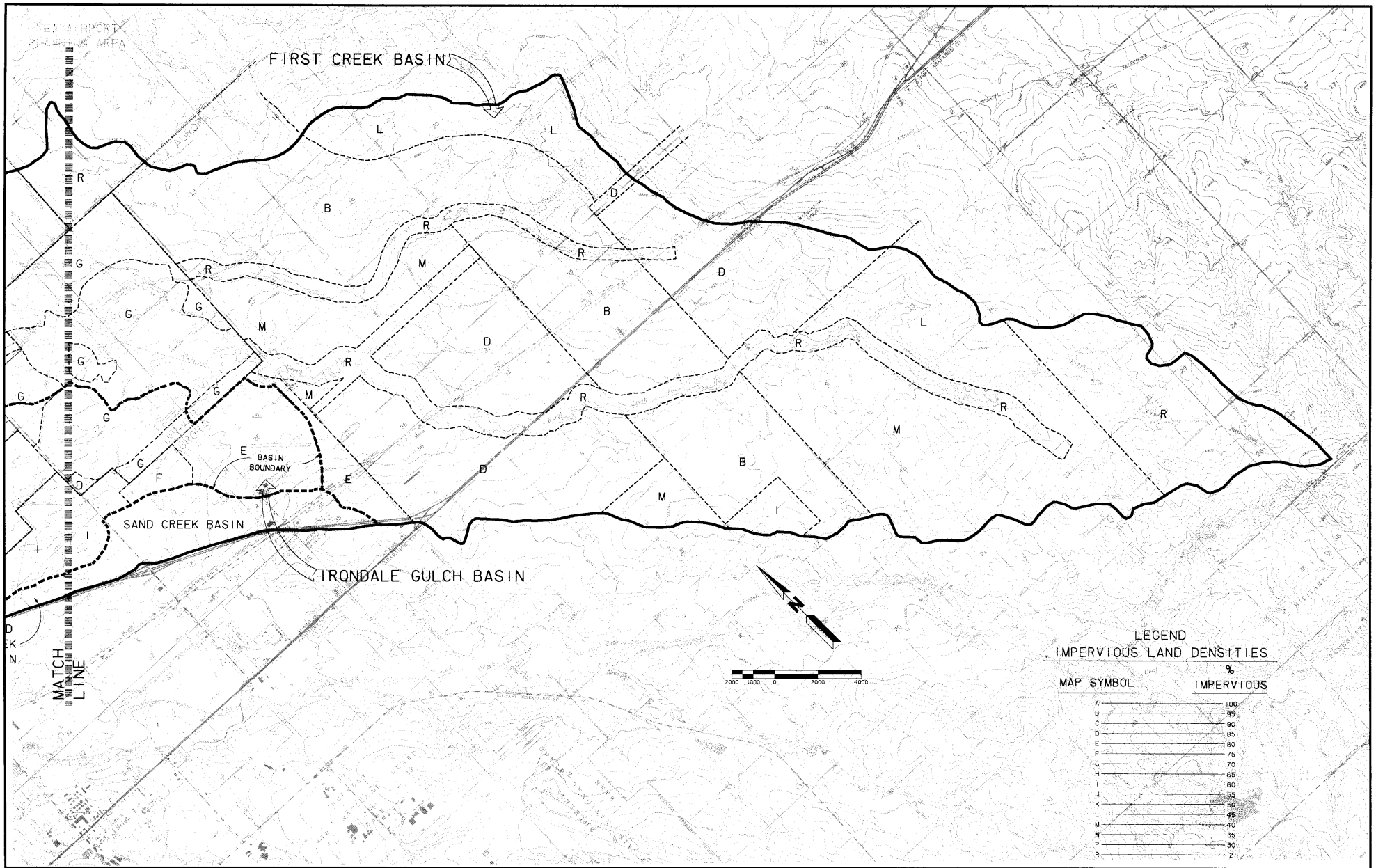
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

PROJECTED IMPERVIOUS LAND DENSITIES WITH AIRPORT



BASE MAPS - U.S.G.S. QUADRANGLE SHEETS: BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS

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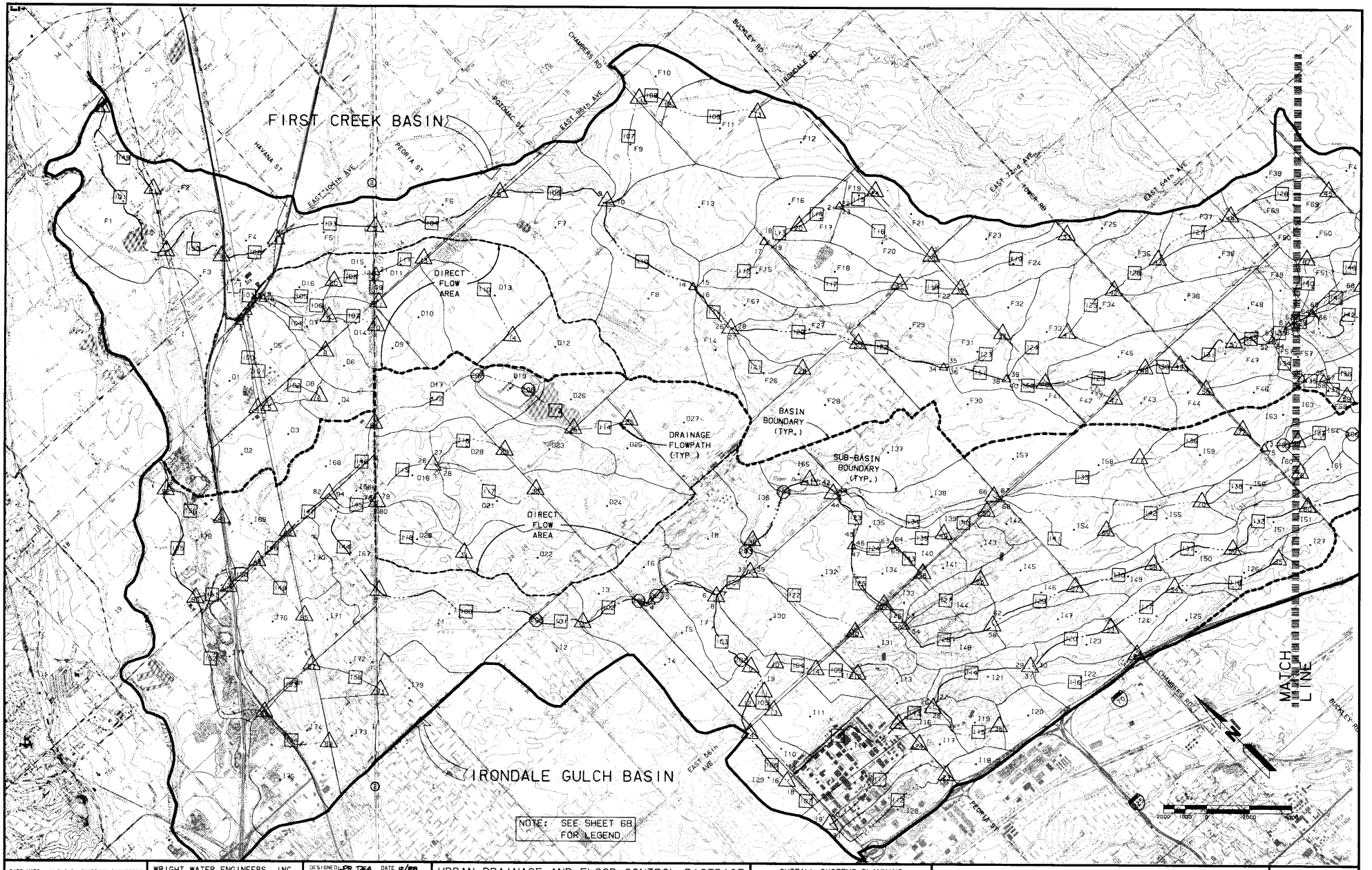
DENVER, COLORADO 80211
(303) 480-1700

DESIGNED JR, DEA DATE 12/88
DRAWN MVN DATE 12/88
CHECKED [illegible] DATE 12/88
REVISED ____ DATE ____

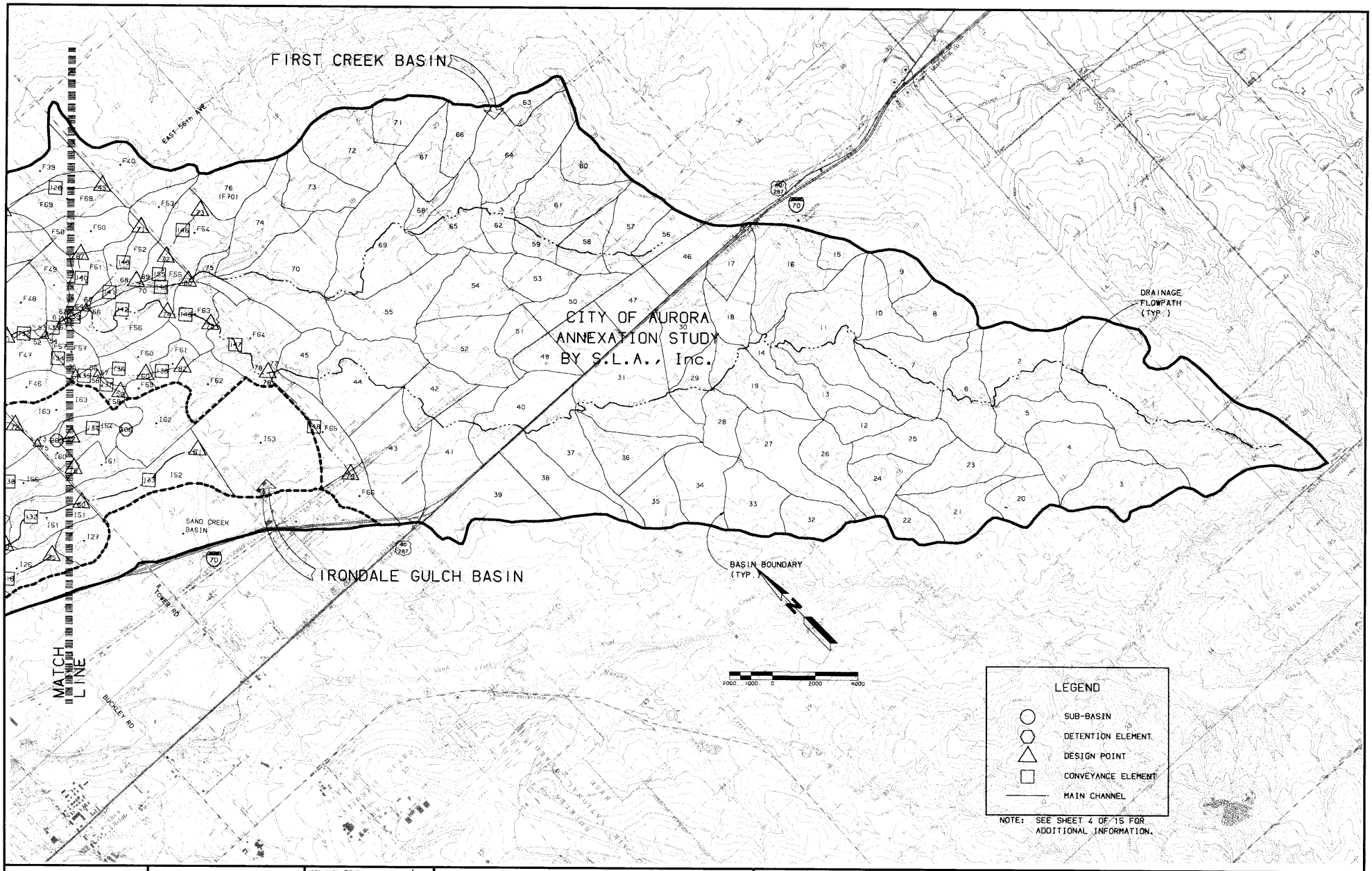
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

PROJECTED IMPERVIOUS LAND DENSITIES WITH AIRPORT



BASE MAPS - U.S.G.S. QUADRANGLE SHEETS: BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS	WRIGHT WATER ENGINEERS, INC. 2490 WEST 26th AVE. - SUITE 100A DENVER, COLORADO 80211 (303) 480-1700	DESIGNED PR DEA DATE 2/88 DRAWN MKH DATE 2/88 CHECKED DEA DATE 2/88 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT ADAMS COUNTY, CITY AND COUNTY OF DENVER, CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY	OUTFALL SYSTEMS PLANNING FIRST CREEK, IRONDALE GULCH, AND DFA 0055	ROUTING ELEMENTS AND SUB-BASINS	SHEET 6A OF 15



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(303) 480-1700

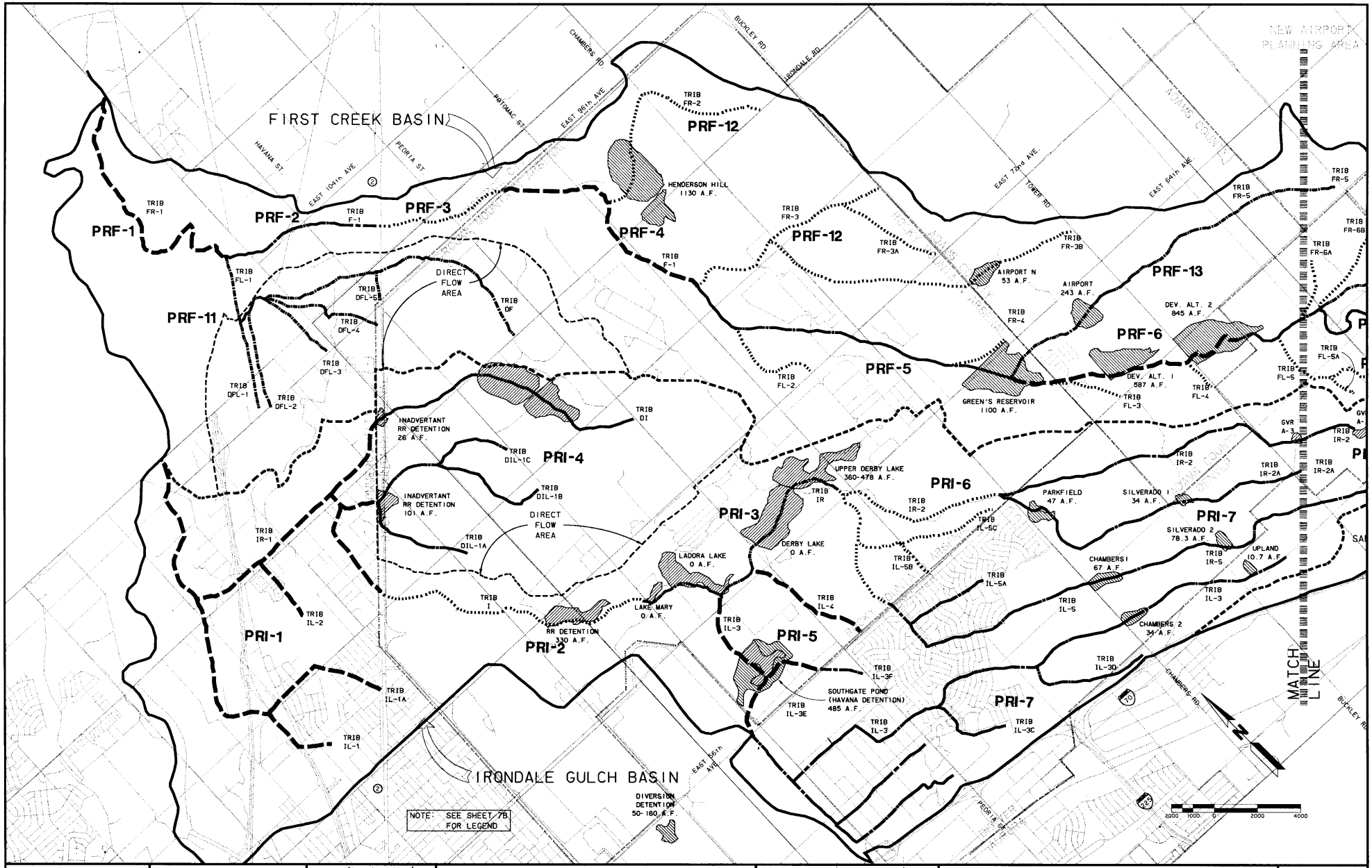
DESIGNED	DPR,DEA	DATE 12/88
DRAWN	MVM	DATE 12/88
CHECKED	DPR	DATE 12/88
REVISED		DATE

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH,
AND DFA 0055

ROUTING ELEMENTS AND SUB-BASINS

SHEET 6B OF 15



BASE MAPS - U.S.G.S. QUADRANGLE SHEETS: BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS

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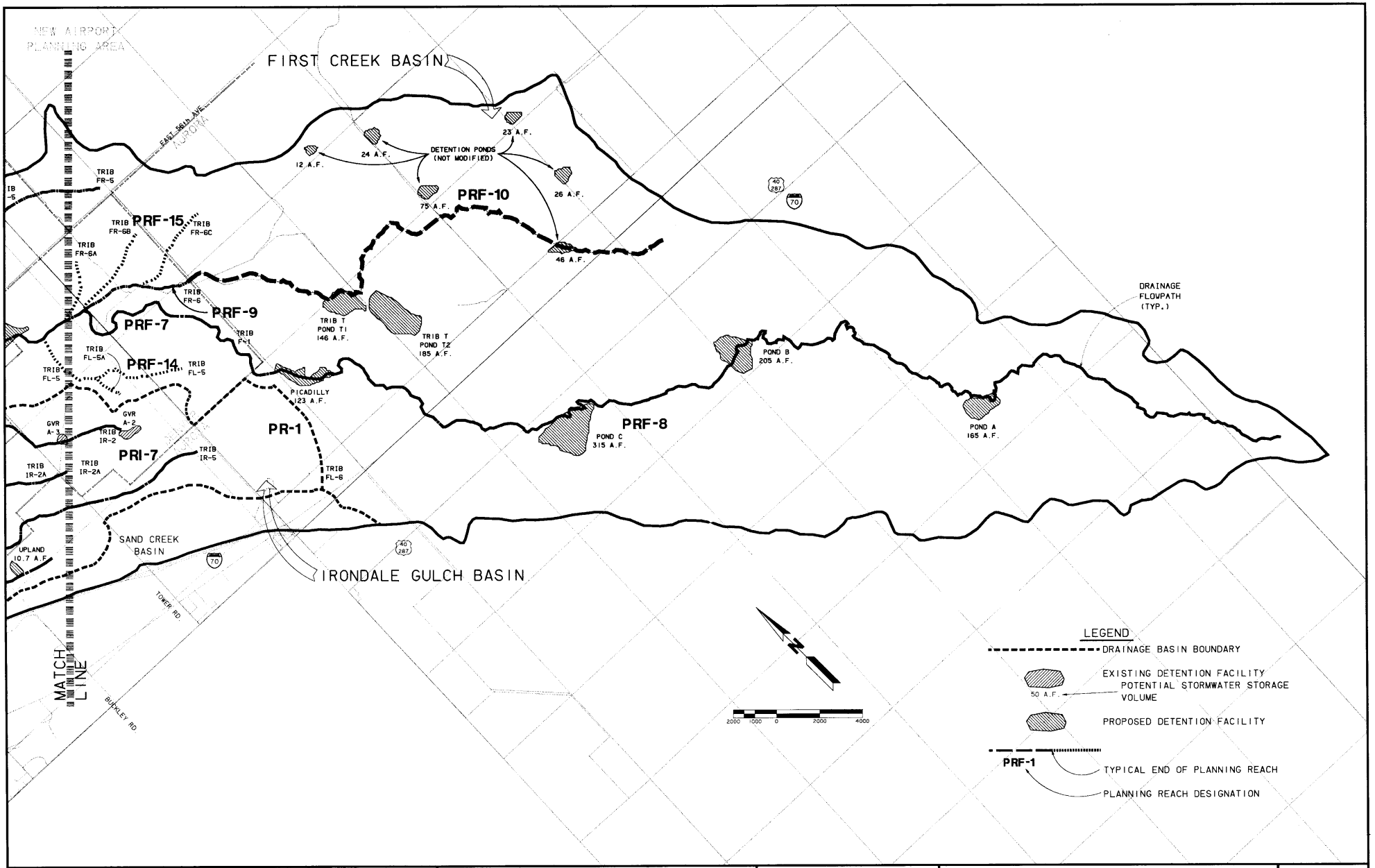
CHECKED [illegible] DATE 12/88
REVISED _____ DATE _____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

PLANNING REACHES
FIRST CREEK AND IRONDALE GULCH



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WRIGHT WATER ENGINEERS, INC.
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DENVER, COLORADO 80211
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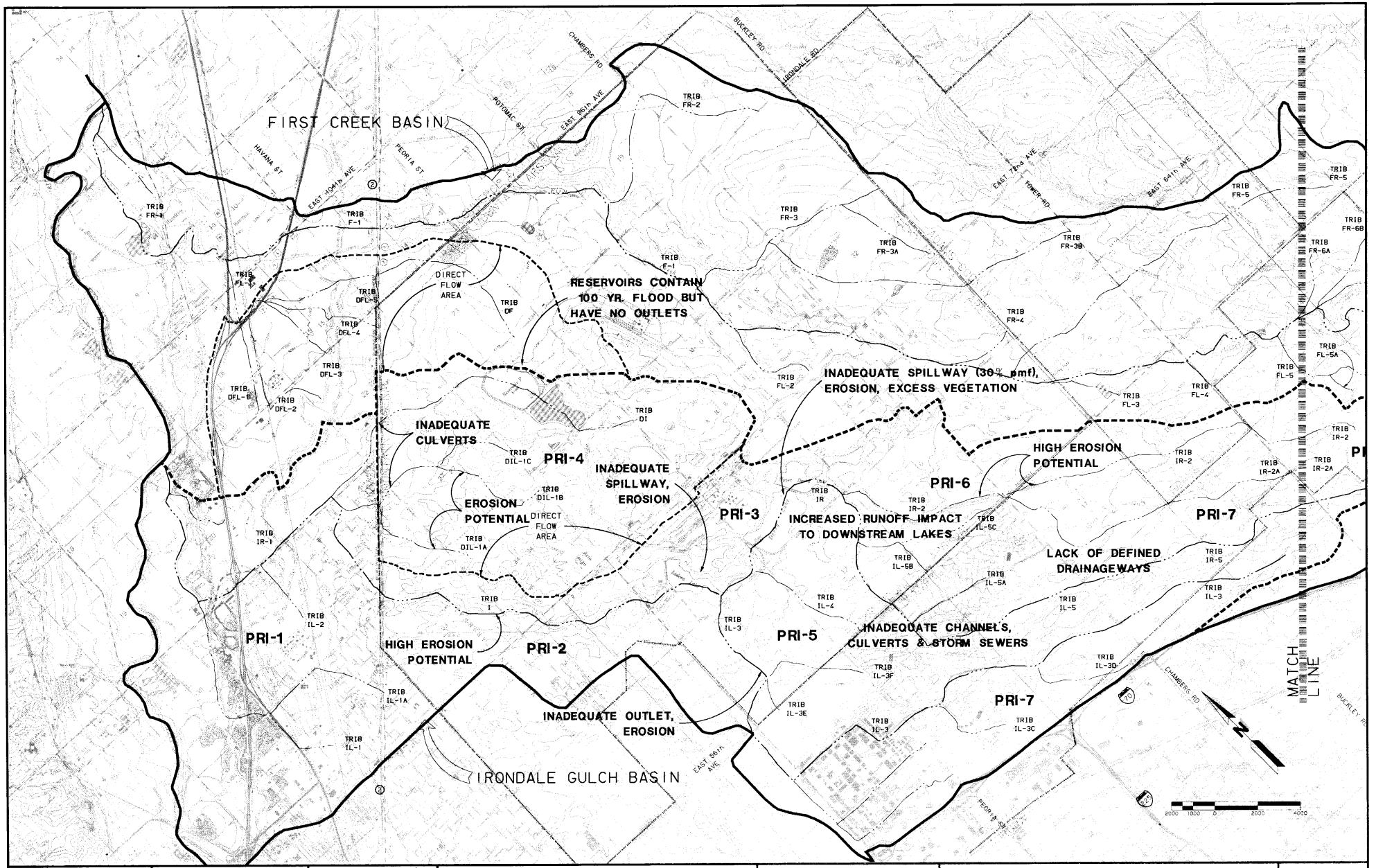
DESIGNED DR DEA DATE 12/98
DRAWN MVN DATE 12/98
CHECKED DD DATE 12/98
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

PLANNING REACHES
FIRST CREEK AND IRONDALE GULCH

SHEET 7B OF 15



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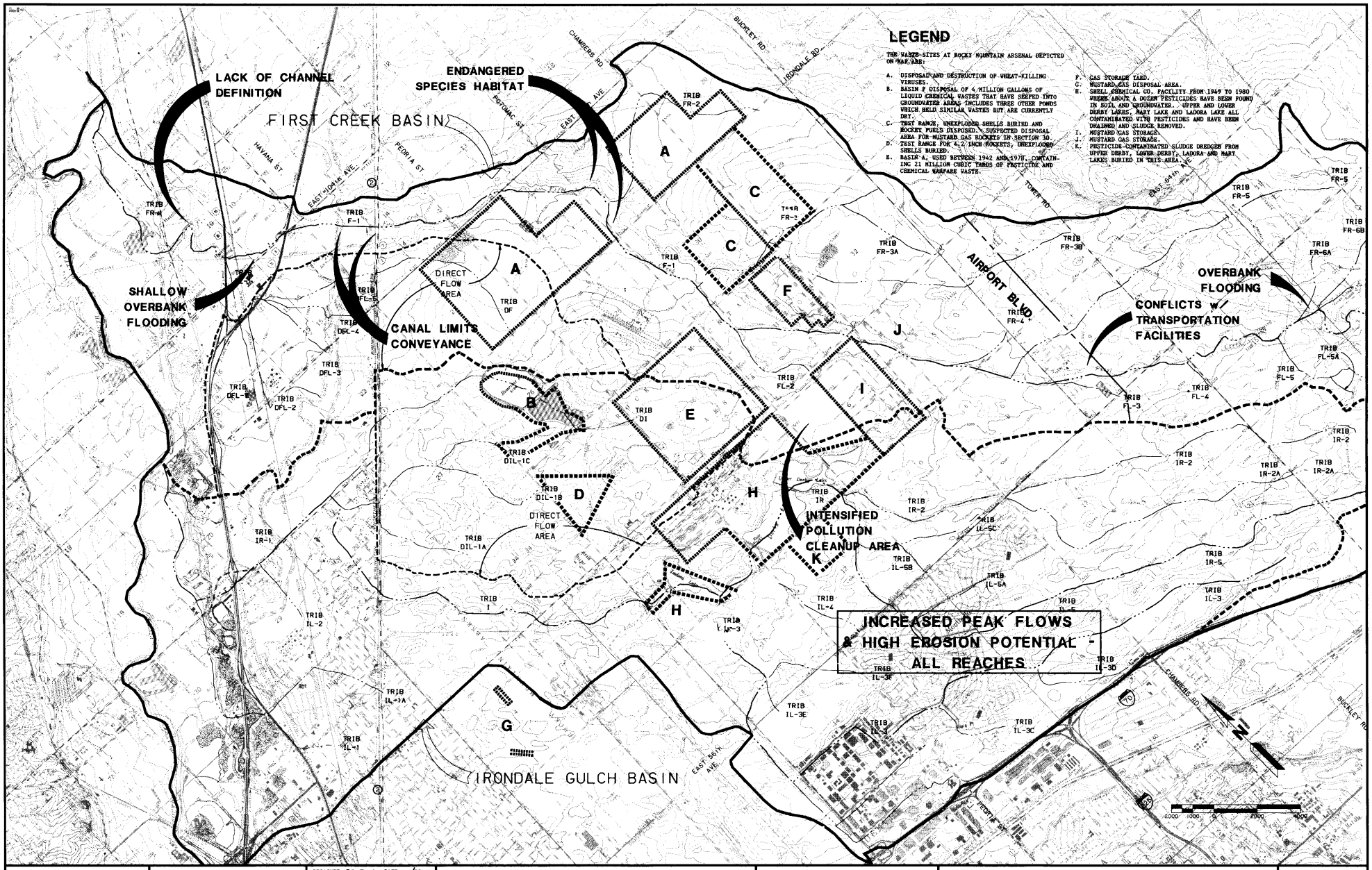
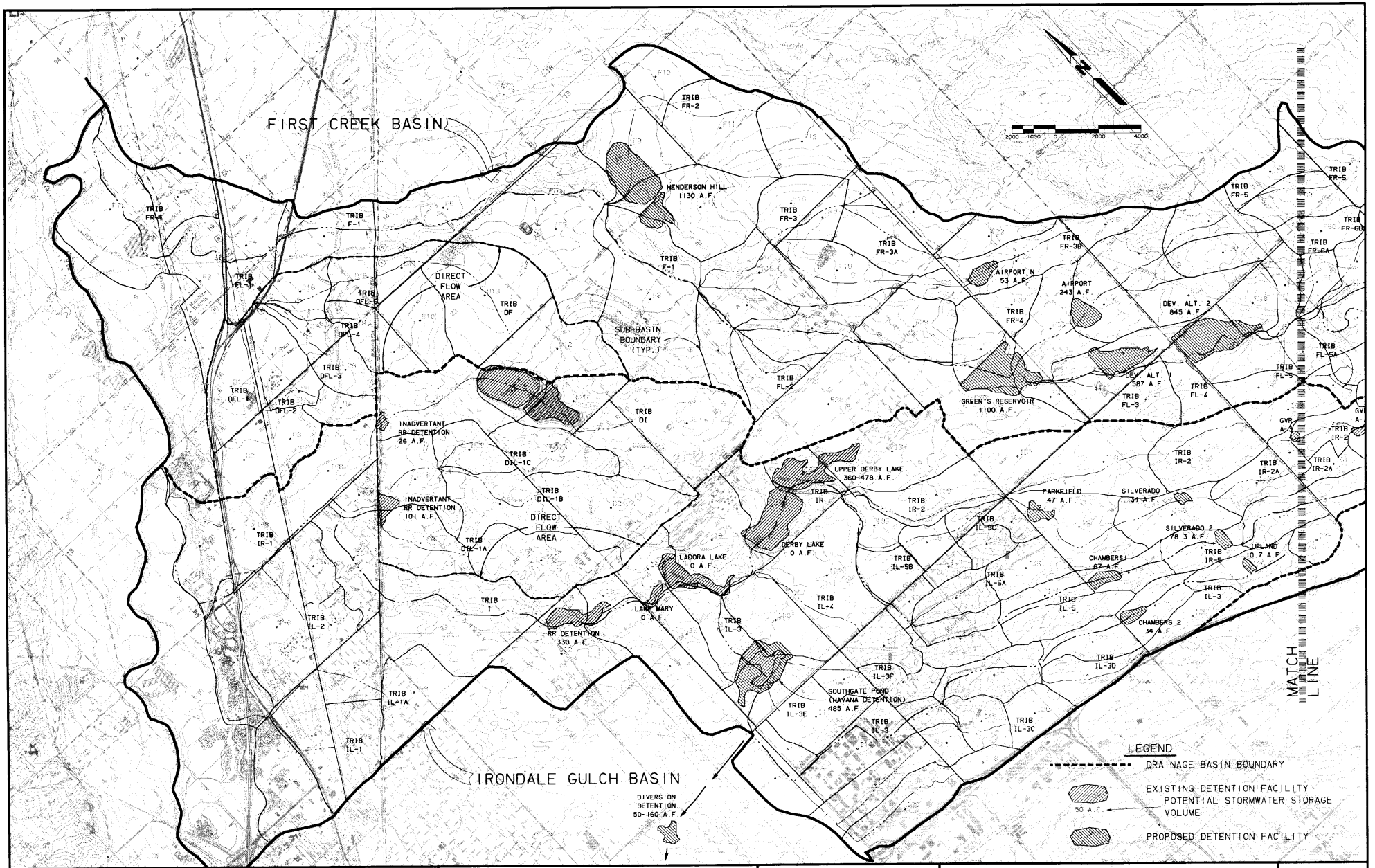
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER, CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

DRAINAGE & EROSION PROBLEM AREAS IN IRONDALE GULCH BASIN



BASE MAPS - U.S.G.S. QUADRANGLE SHEETS: BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS	WRIGHT WATER ENGINEERS, INC. 2490 WEST 26th AVE. - SUITE 100A DENVER, COLORADO 80211 (303) 480-1700	DESIGNED DEA DATE 12/88 DRAWN MVN DATE 12/88 CHECKED DEA DATE 12/88 REVISED ____ DATE ____	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT ADAMS COUNTY, CITY AND COUNTY OF DENVER, CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY	OUTFALL SYSTEMS PLANNING FIRST CREEK, IRONDALE GULCH, AND DFA 0055	DRAINAGE & EROSION PROBLEM AREAS IN FIRST CREEK BASIN	SHEET 8B OF 15



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DENVER, COLORADO 80211
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DESIGNED DR, DEA DATE 12/88
DRAWN MVN DATE 12/88
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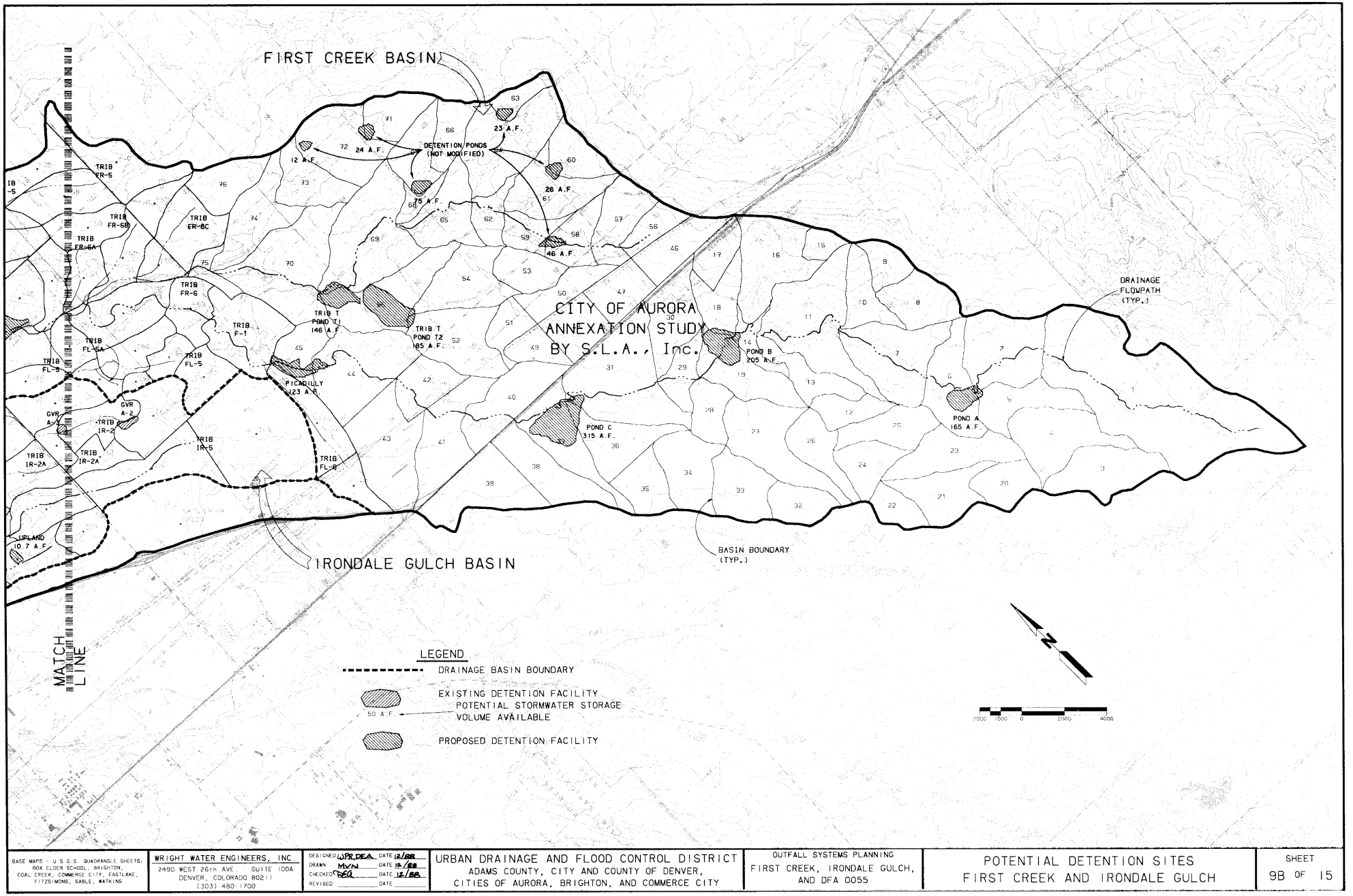
REVISED ____ DATE ____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

POTENTIAL DETENTION SITES FIRST CREEK AND IRONDALE GULCH

SHEET 9A OF 15



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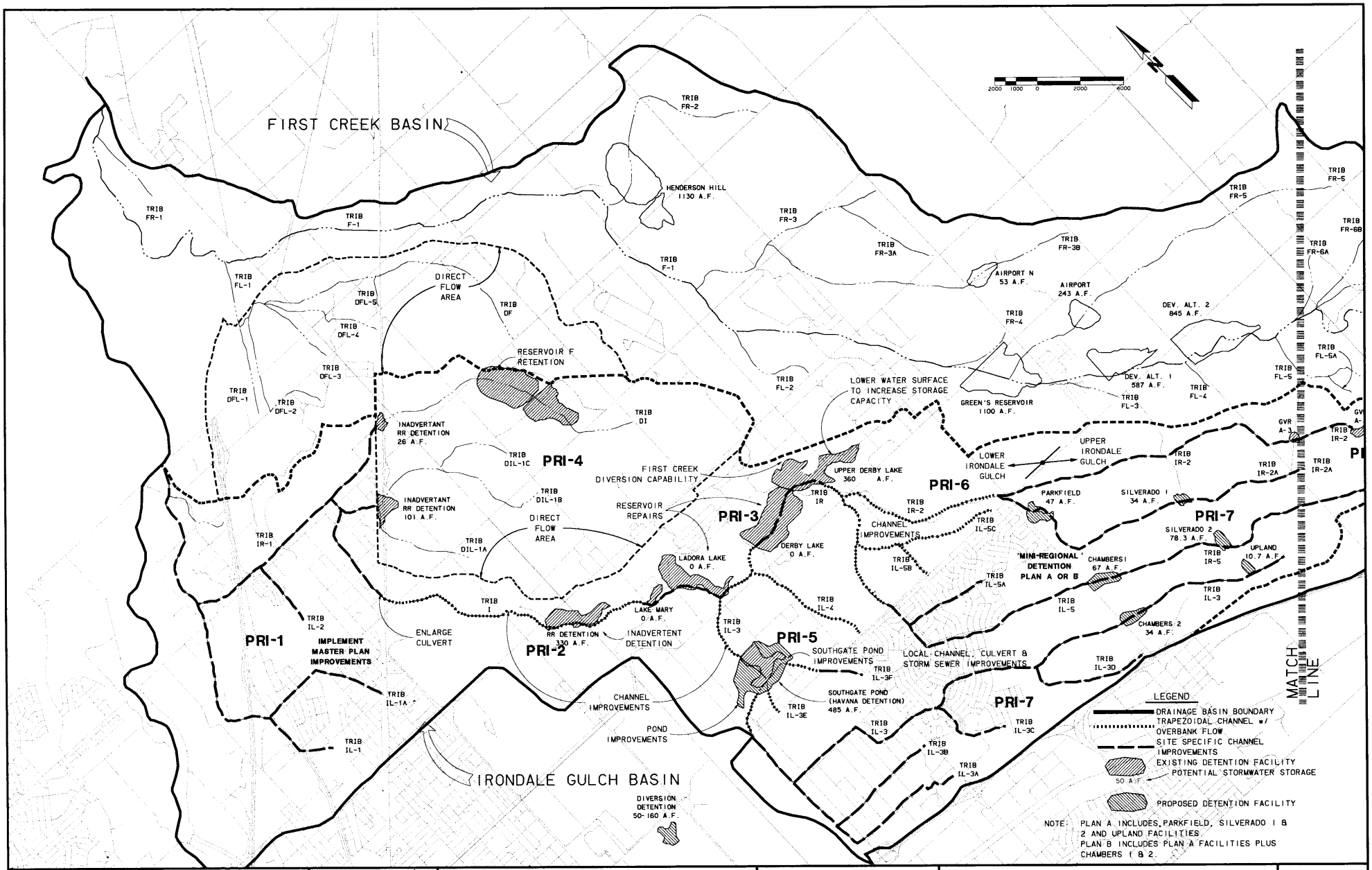
REVISED DATE

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER, CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

POTENTIAL DETENTION SITES FIRST CREEK AND IRONDALE GULCH



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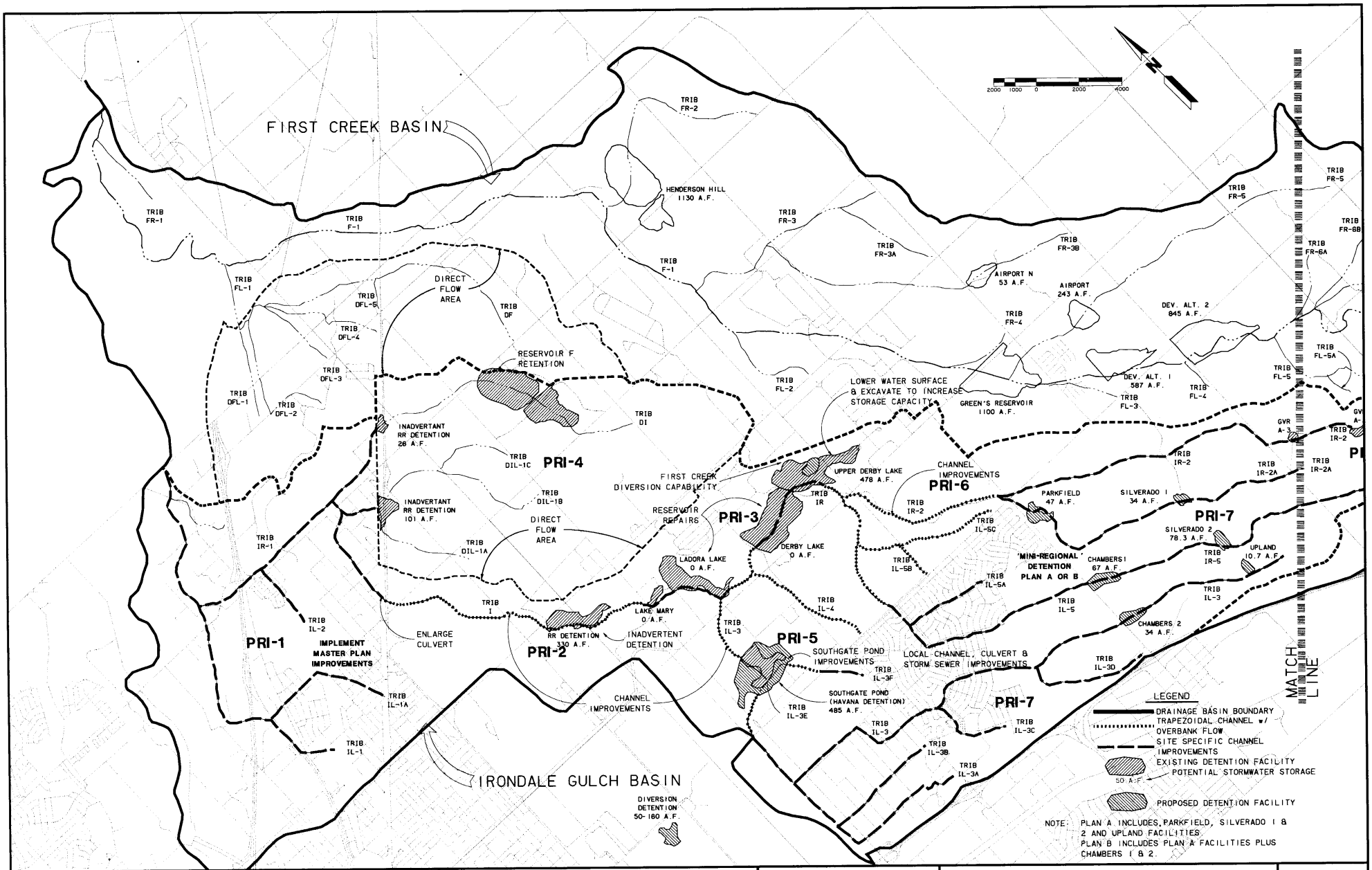
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

IRONDALE GULCH
STORM DRAINAGE ALTERNATIVES - PLAN 1

SHEET 10A OF 15



BASE MAPS - U.S.G.S. QUADRANGLE SHEETS, BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS

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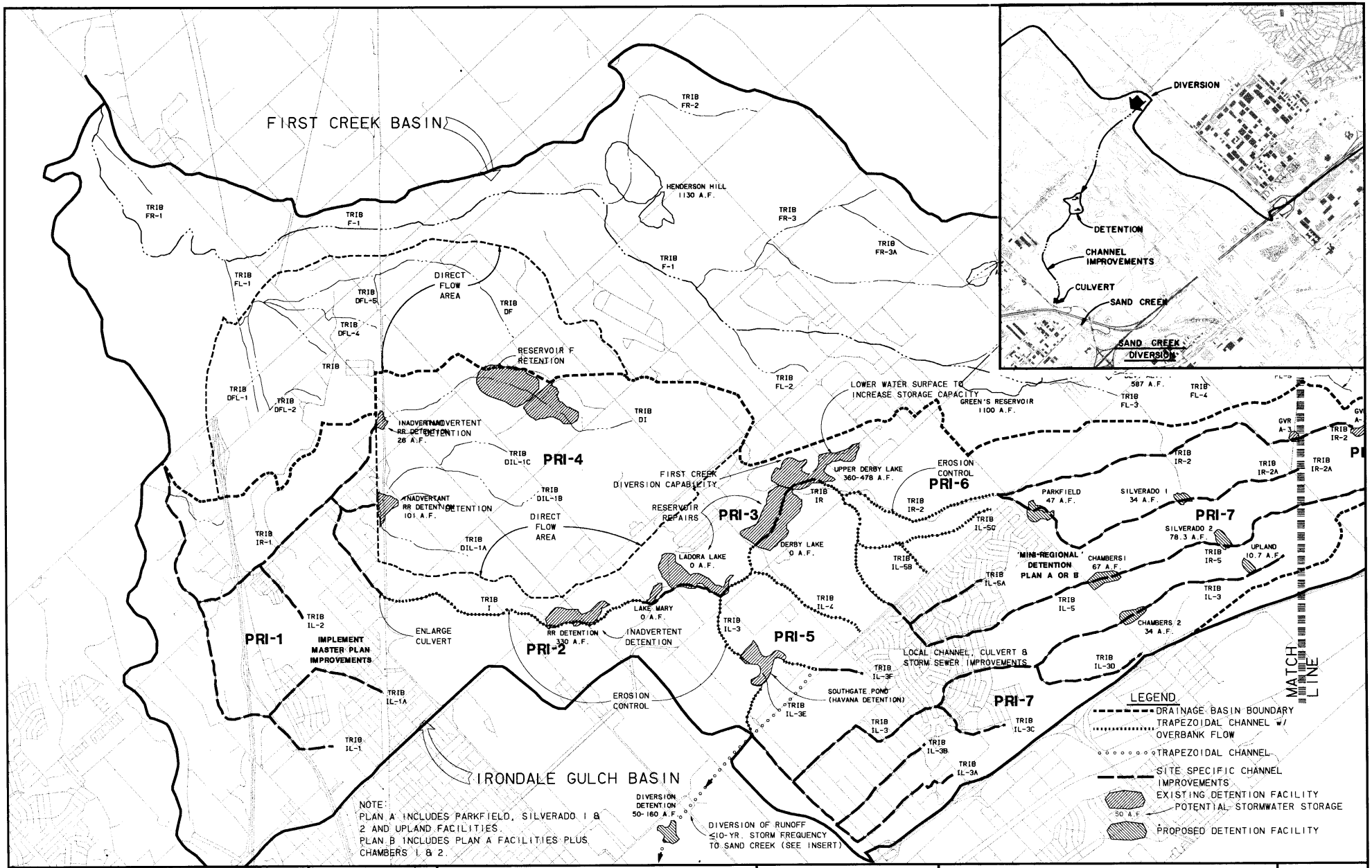
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER, CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

IRONDALE GULCH STORM DRAINAGE ALTERNATIVES - PLAN 2

SHEET 108 OF 15



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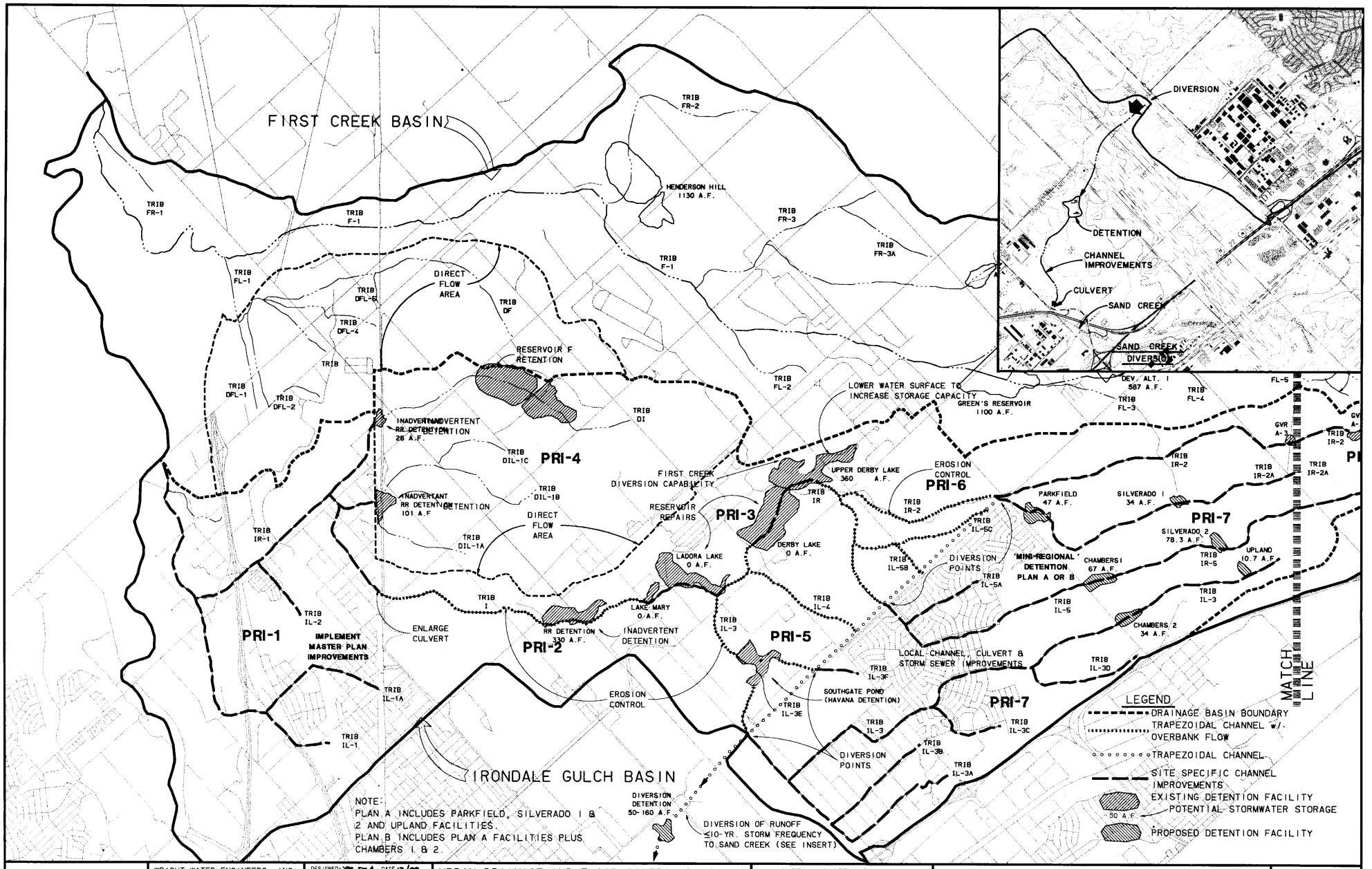
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

IRONDALE GULCH STORM DRAINAGE ALTERNATIVES - PLAN 3

SHEET 10C OF 15



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DRAWN MVM DATE 12/88
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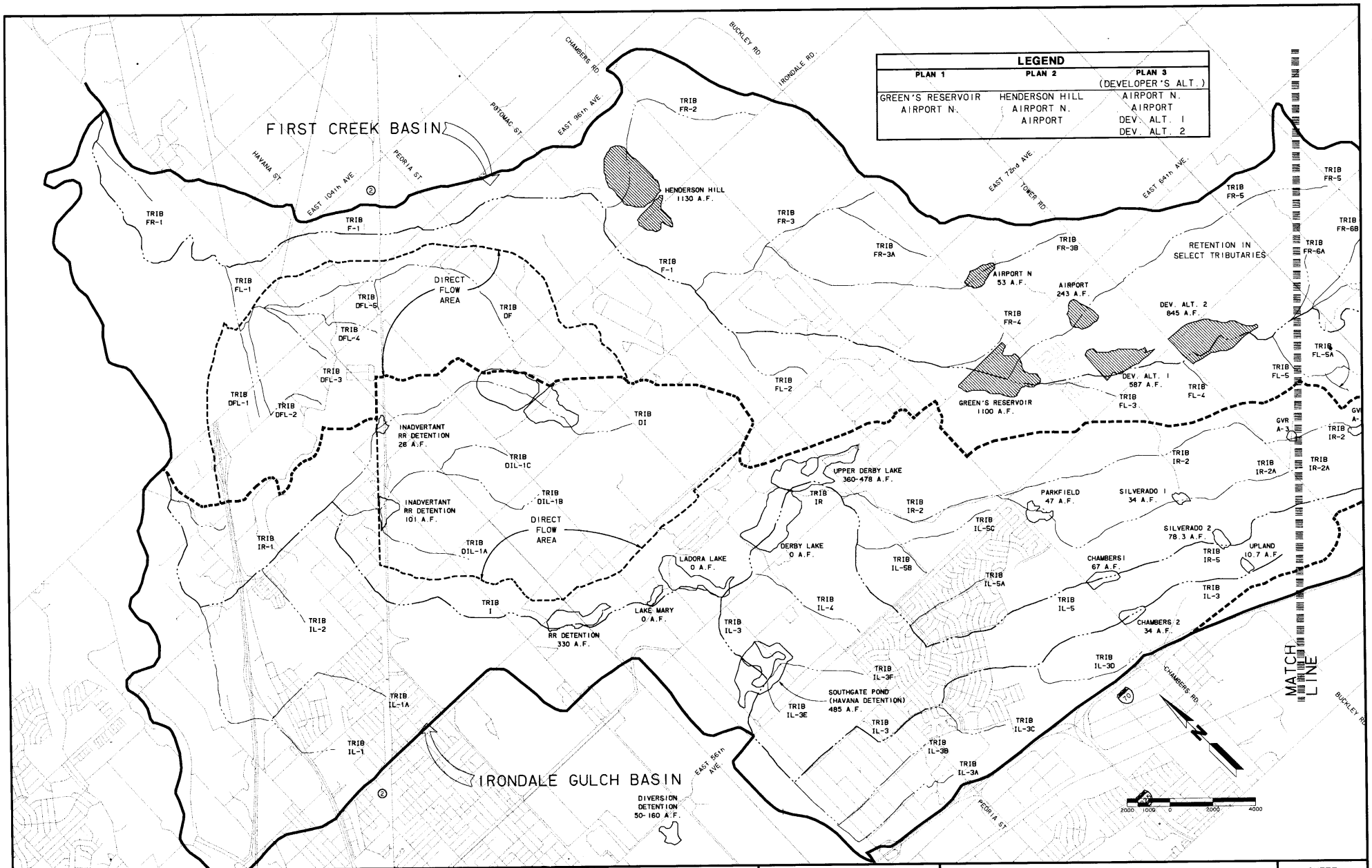
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER, CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

IRONDALE GULCH STORM DRAINAGE ALTERNATIVES - PLAN 4

SHEET 10D OF 15



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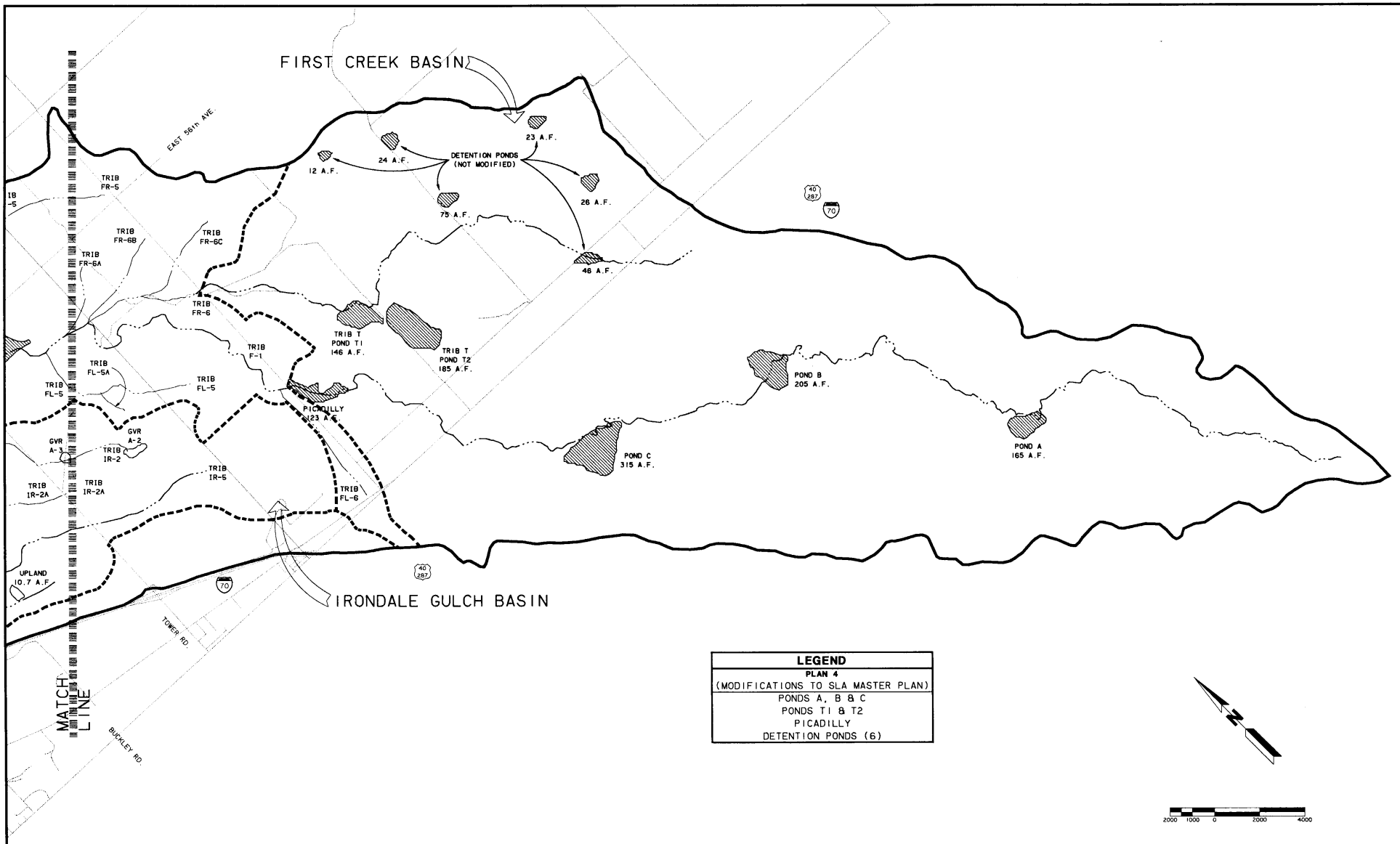
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

FIRST CREEK DETENTION PLANS

SHEET IIA OF 15



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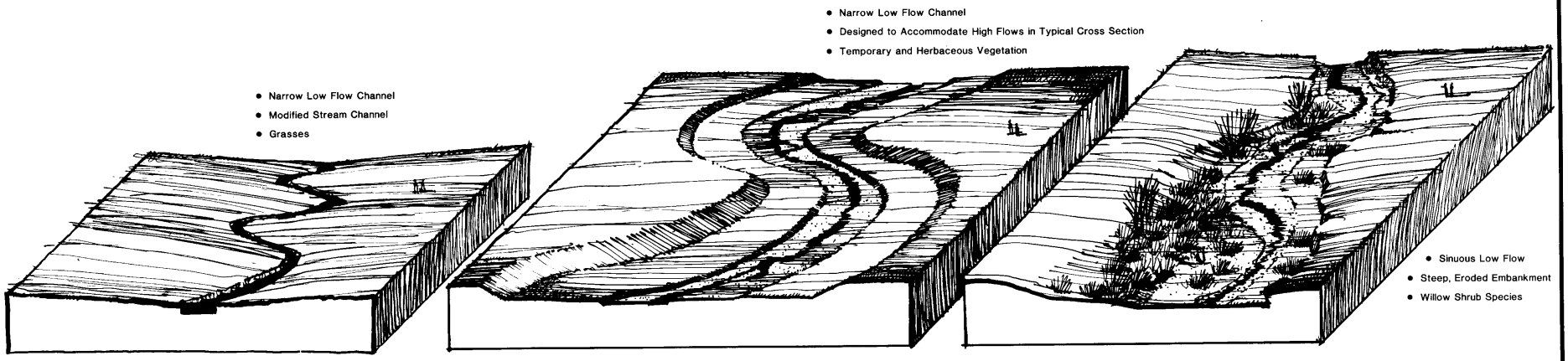
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH,
AND DFA 0055

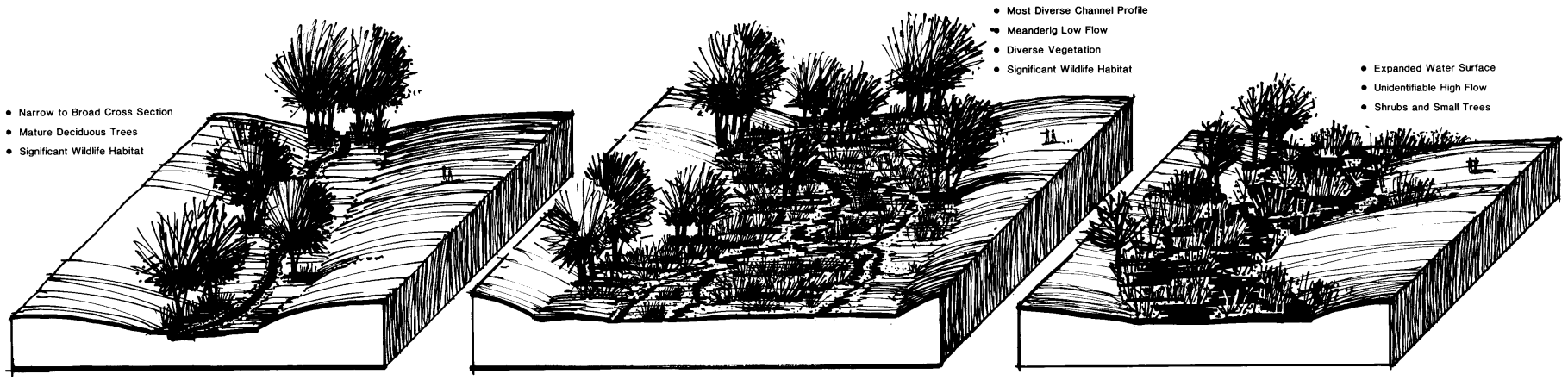
FIRST CREEK DETENTION PLANS



1-CULTIVATED CHANNEL

2-ENGINEERED FLOODWAY

3-SHRUB DOMINATED CHANNEL



4-FORESTED CHANNEL

5-FORESTED RIPARIAN CHANNEL

6-BACKWATER WETLAND

WILLIAM WENK ASSOCIATES
LANDSCAPE ARCHITECTS
1900 WAZEE STREET SUITE 360
DENVER, COLORADO 80202
(303) 295-0778

ERIK OLGEIRSON, Ph.D.
CONSULTING ECOLOGIST
MICHAEL STEVENS
CONSULTING ENGINEER

WRIGHT WATER ENGINEERS, INC.
2490 WEST 26th AVENUE SUITE 65A
DENVER, COLORADO 80211
(303)480-1700

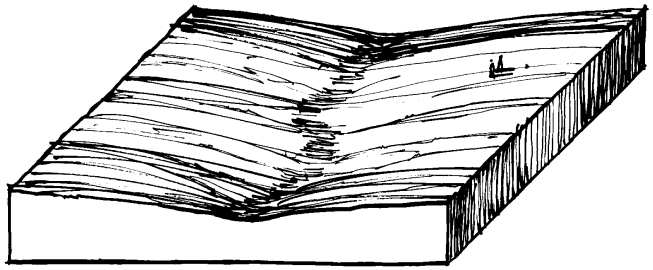
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

DATE: June 8, 1988

TYPICAL CHANNEL UNITS
FIRST CREEK

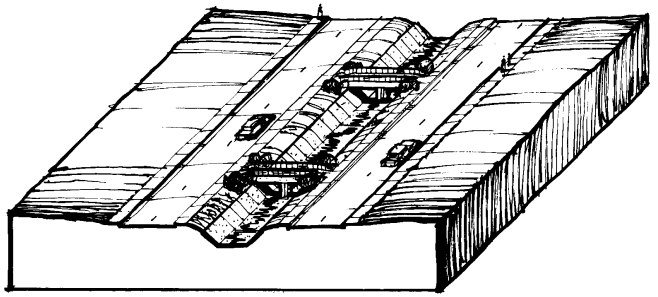
DRAWING
12A

- No Low Flow Channel
- Grasses
- Includes Tertiary Channels in First Creek



7 GRASSLAND / PRAIRIE SWALE

- Paved, Open Channel
- Includes Piped Channels and Drainage Along Roads



8-PAVED CHANNEL

WILLIAM WENK ASSOCIATES
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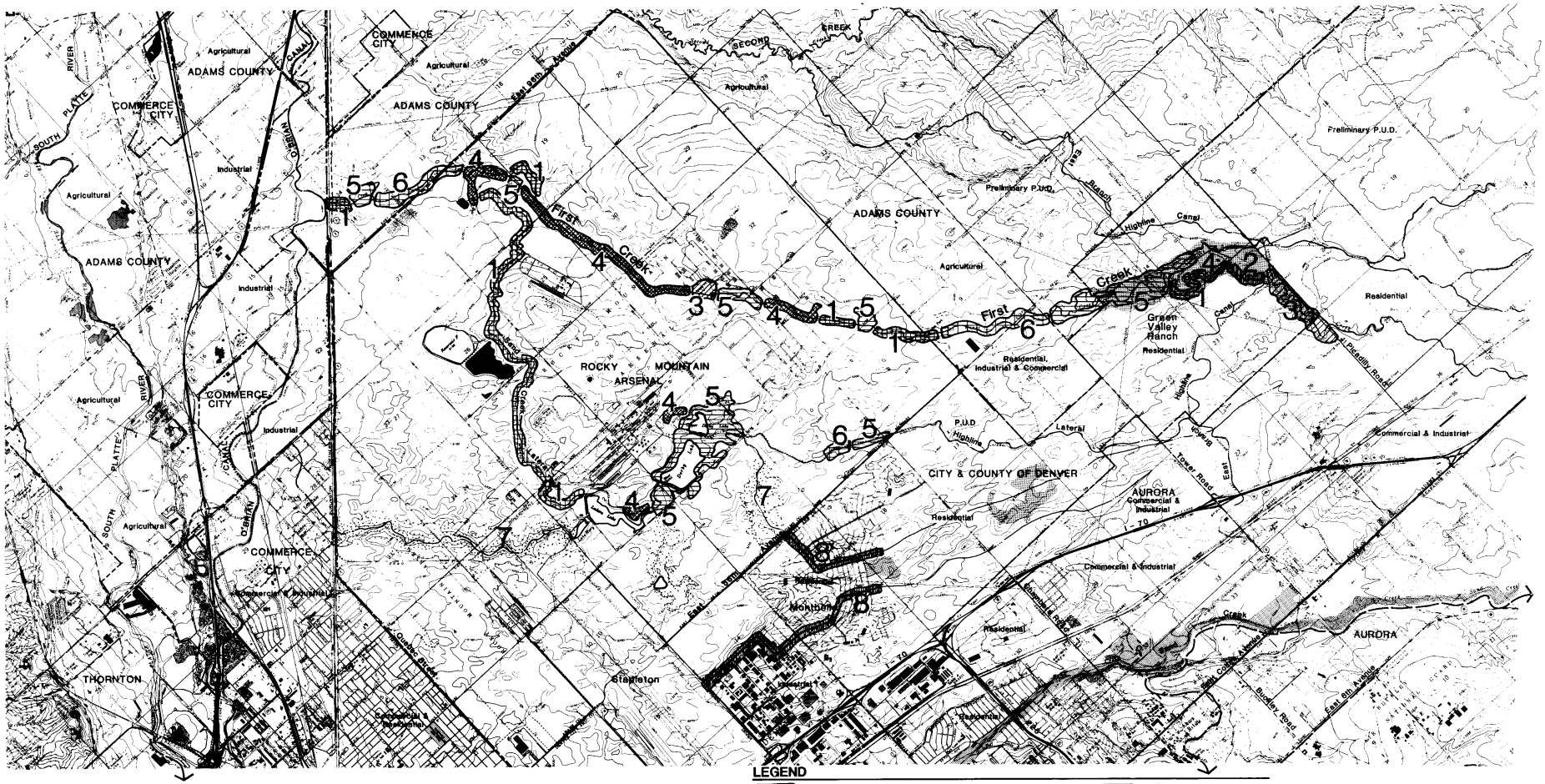
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

DATE: June 8, 1988

TYPICAL CHANNEL UNITS
IRONDALE GULCH DRAINAGEWAY

DRAWING
12B



LEGEND

1 – AGRICULTURAL/CULTIVATED ALLUVIAL CHANNEL
2 – ENGINEERED FLOODWAY
3 – SHRUB DOMINATED CHANNEL
4 – FORESTED CHANNEL
5 – FORESTED RIPARIAN WETLAND
6 – BACKWATER WETLAND
7 – Grassland/Prairie Swale
8 – Paved Channel
Lakes & Drawdowns
Existing Open Space
Existing Trail

Scale 1" : 2000'-0" North

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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

DATE: May 26th, 1988

PRELIMINARY INVENTORY MAP
FIRST CREEK & IRONDALE GULCH DRAINAGEWAYS

DRAWING 13

ENGINEERED FLOODWAY

SCALE 1"=20'-0"

ENGINEERED GRASS/WETLAND CHANNEL

SCALE 1"=20'-0"

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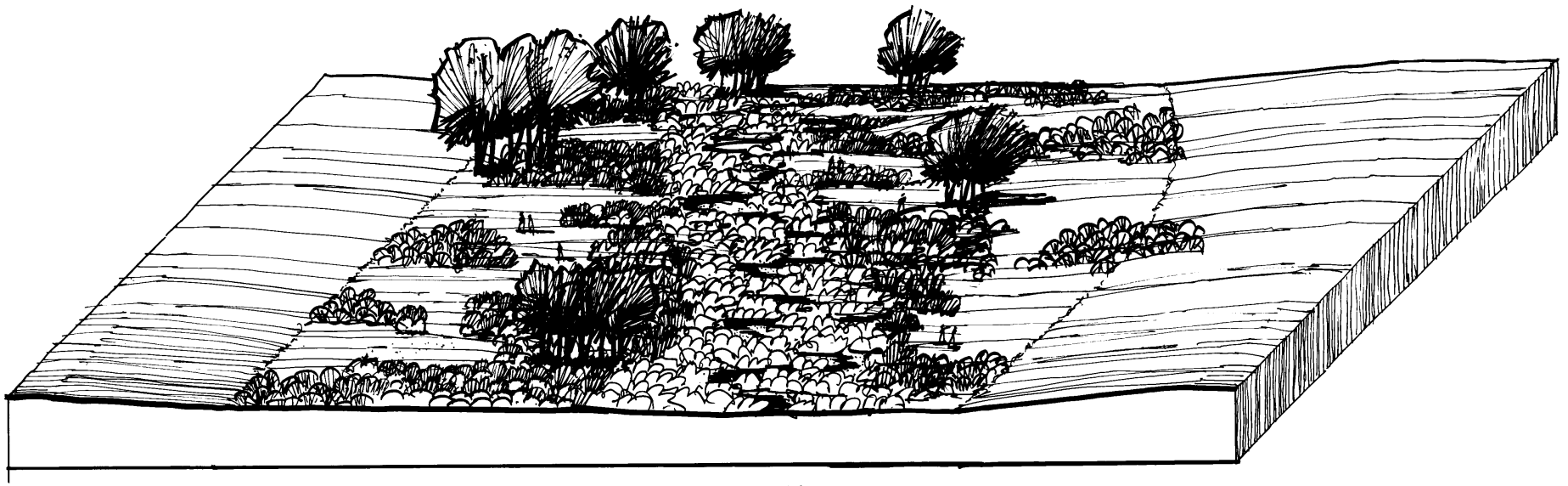
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

DATE: June 8, 1988

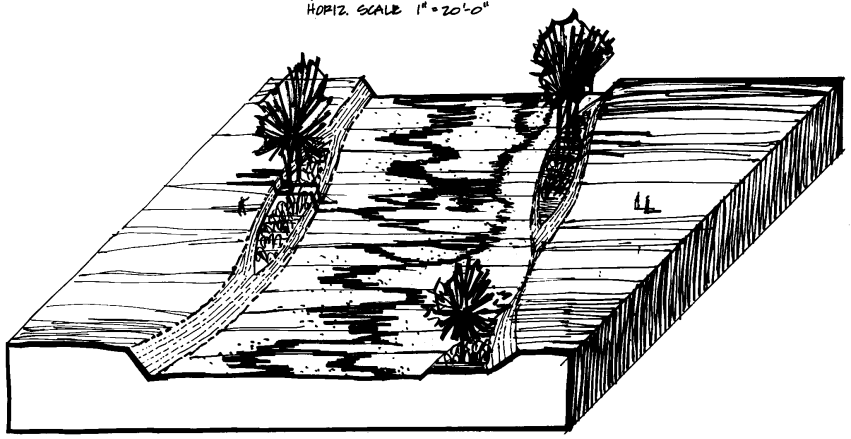
CHANNEL DESIGN ALTERNATIVES
FIRST CREEK

DRAWING
14A



NATURAL OPEN SPACE CONVEYANCE

VERTICAL SCALE 1" = 20'-0"
HORIZ. SCALE 1" = 20'-0"



HARD LINED CHANNEL

VERTICAL SCALE 1" = 20'-0"
HORIZ. SCALE 1" = 20'-0"

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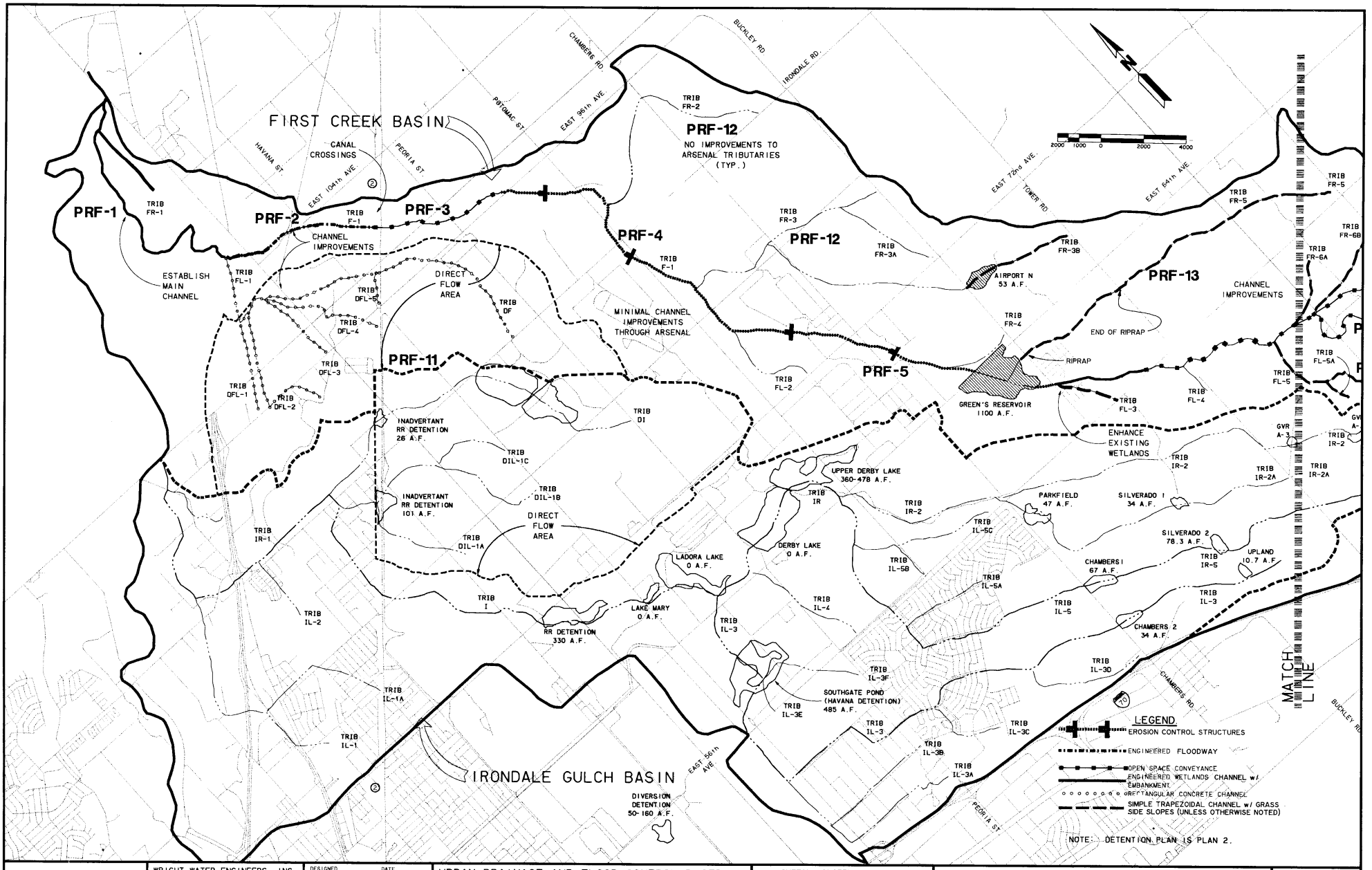
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

DATE: June 8, 1988

CHANNEL DESIGN ALTERNATIVES
FIRST CREEK

DRAWING
14B



BASE MAPS - U.S.G.S. QUADRANGLE SHEETS: BOX ELDER SCHOOL, BRIGHTON, COAL CREEK, COMMERCE CITY, EASTLAKE, FITZSIMONS, SABLE, WATKINS

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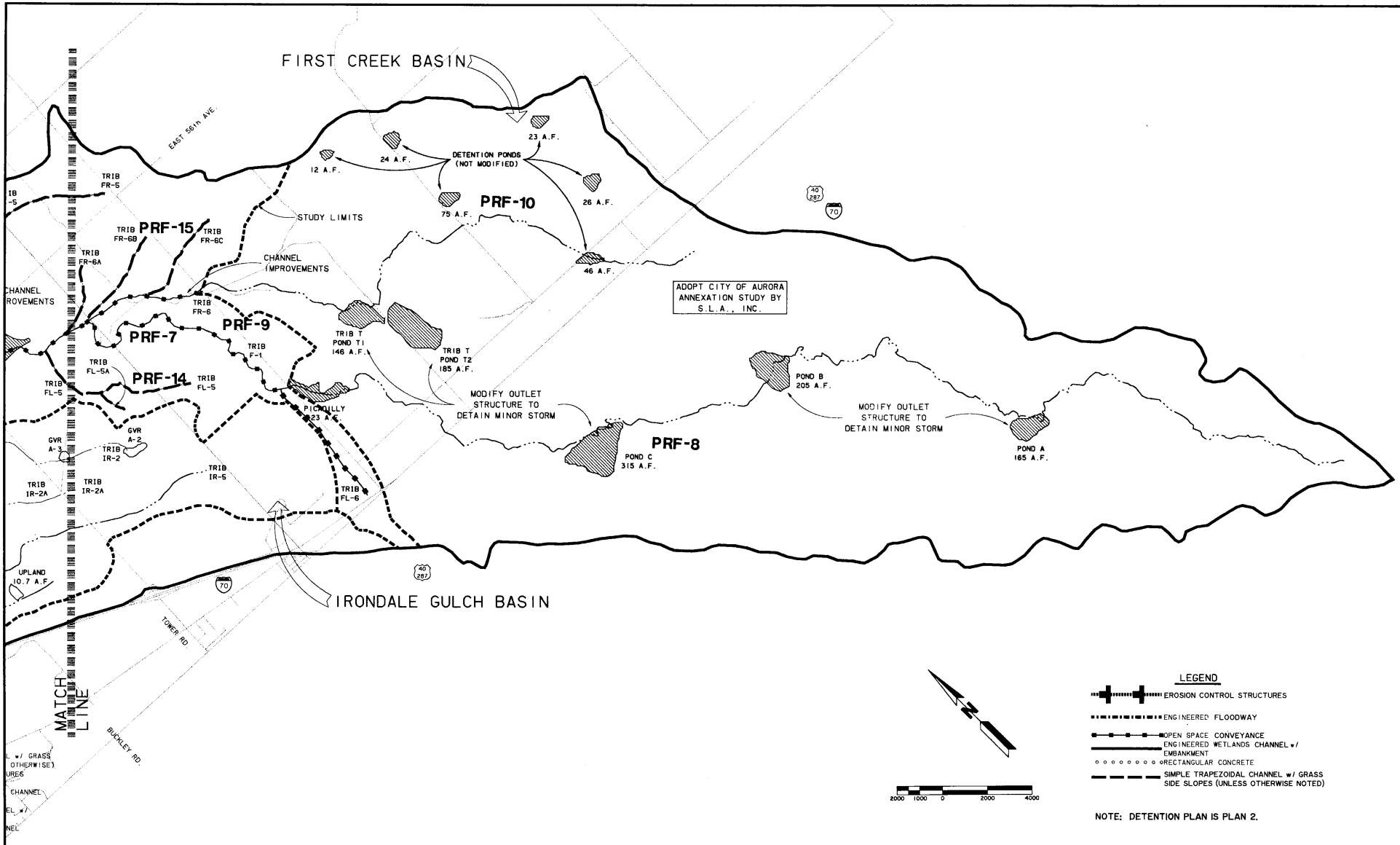
REVISED _____ DATE _____

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER, CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

FIRST CREEK STORM DRAINAGE ALTERNATIVES
WWE RECOMMENDED PLAN

SHEET 15A OF 15



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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
ADAMS COUNTY, CITY AND COUNTY OF DENVER,
CITIES OF AURORA, BRIGHTON, AND COMMERCE CITY

OUTFALL SYSTEMS PLANNING
FIRST CREEK, IRONDALE GULCH, AND DFA 0055

FIRST CREEK STORM DRAINAGE ALTERNATIVES
WWE RECOMMENDED PLAN